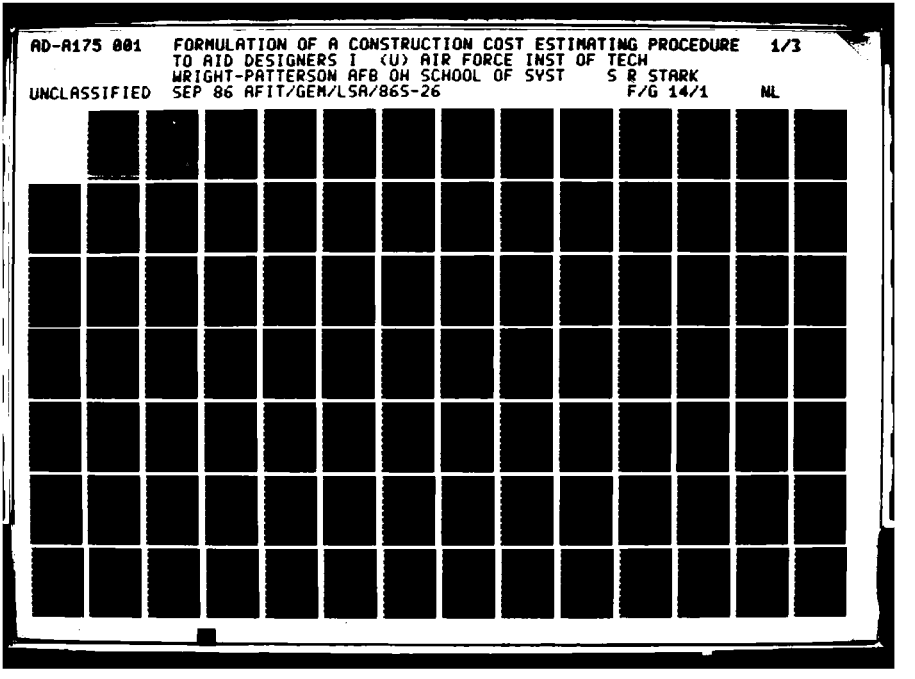
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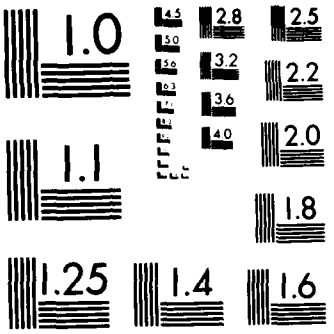

FORMULATION OF A CONSTRUCTION COST ESTIMATING PROCEDURE TO AID DESIGNERS IN PREPARING DETAILED CONSTRUCTION COST ESTIMATES

THESIS

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Captain, USAF

AFIT/GEM/LSA/86S-26

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Wright-Patterson Air Force Base, Ohio

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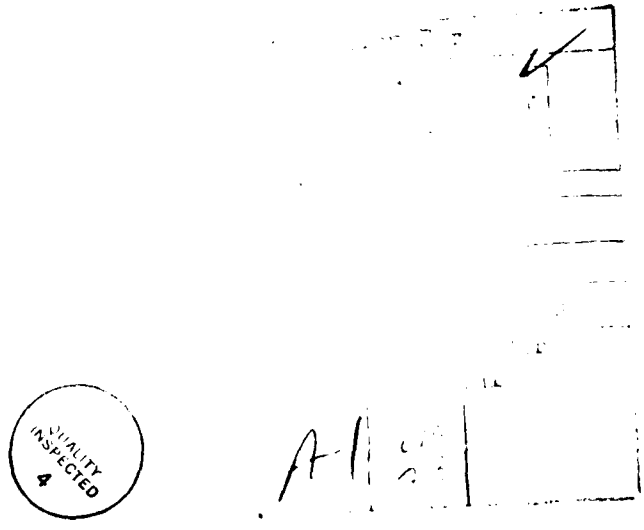

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FORMULATION OF A CONSTRUCTION COST ESTIMATING PROCEDURE TO AID DESIGNERS IN PREPARING DETAILED CONSTRUCTION COST ESTIMATES

THESIS

Presented to the Faculty of the School of Systems and Logistics

of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the

Requirements for the Degree of

Masters of Science in Engineering Management-Technical Applications

Steven R. Stark, B.A. in Arch.

Captain, USAF

September 1986

Acknowledgments

I wish to extend my appreciation to all those who contributed to the completion of my thesis project.

First of all, thanks to my advisor, Lt. Col. Dale Shields, for his guidance and keeping me on track throughout the entire process.

I also wish to thank the Construction Cost Estimating Class (ENG400) students at the School of Civil Engineering for allowing me to use them as a trial case to test my research project. Also, thanks to the MGTA5.07 Construction Cost Estimating class 86S for all your help in creating a test data base.

Finally, thanks to my wife, Patricia, for being so supportive and encouraging when I needed it the most.

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Abstract

This thesis examined several existing cost estimating data bases. In addition to examining these data bases a survey was taken amoung Air Force Civil Engineering design personnel to determine which estimating system is currently in use and what factors effect the final costs on construction projects. Based on the results of the surveys an estimating program was developed to enable the designer to input local cost data and store the data for future use. With the data base in place the designer is able to create accurate cost estimates in less time for each particular project and have the project data stored under the particular project name/code. The computer programs developed for this thesis were written in BASIC language and compatible with the WANG VS 100 system.

FORMULATION OF A CONSTRUCTION COST ESTIMATING PROCEDURE TO AID DESIGNERS IN PREPARING DETAILED CONSTRUCTION COST ESTIMATES

I. Introduction

General Issue

The Federal Acquisition Regulation (FAR) 36.203(a) requires that an independent cost estimate be prepared for all construction projects estimated to cost over $25,000. The Government estimate is to be given to the contracting officer at the earliest practicable time for each contract. The FAR requires that the estimate be prepared in as much detail as if the Government were competing for the award along with the contractors (6:36-2).

The difference between bid prices and the government estimates has been an area of continuing concern. In 1973, concern about the difference between bid prices and government estimates lead Mr. Laird, then Secretary of Defense, to establish the Office, Secretary of Defense Cost Analysis Improvement Group to help validate government estimates (7:3). Despite such high level attention the problem persists. One 1984 study found that in over 50 percent of the actions examined the government estimate varied by more than 20 percent, high or low, when compared to the bid price (12:2).

Problem Statement

The FAR requires a detailed cost estimate to be furnished to the contracting officer prior to advertising a construction project. The low

responsive and responsible bidder will receive the contract award for constructing the project. A responsive bid is a bid that complies in all material respects with the invitation for bids (6:14-9). A responsible bid is determined by the contracting officer and based on a set of standards. The standards state a contractor must have adequate financial resources; be able to comply with the required delivery or performance schedule; have a satisfactory performance record; have a satisfactory record of integrity and business ethics; have the necessary organization, experience and skills to complete the job; and be otherwise qualified and eligible to receive an award under applicable laws and regulations (6:8-11). The government estimate is used in determining if the contractor bid is reasonable (6:14-16). The government estimate is designated "For Official Use Only" until the bid opening (5:36.2-1). At that time it is opened and compared with the various bids. If the low responsible bid is significantly different than the government estimate, the contracting officer must perform further analysis to determine price reasonableness. If the lowest bid is determined responsive and responsible by the contracting officer an award is made.

A study of 733 construction contracts awarded in FY 83 and FY 84 indicated 299 cases where the government estimate was more than 20 percent higher than the low bid and 93 cases where the government estimate was more than 20 percent lower than the low bid (12:5). Several projects were found to have a government estimate which varied by more than 50 percent from the low bid. For example, at one base the government estimate given to the contracting officer was 519 percent of the low bid (12:5).

The government estimate is used to determine the reasonableness of the contractor's bid. If the bid is high or low when compared to the

government estimate the government estimate is used to pinpoint where a mistake in bid may have occurred. If the contractor's bid is low when compared to the government estimate the contracting officer requests a bid verification from the contractor (6:14-12). A bid verification could also be used to verify a high bid (6:14-13). If the low bid was higher than the government estimate a bid verification could indicate where the government estimate was wrong.

Creation of a valid detailed construction cost estimate is time consuming. The quantities for each construction item are calculated, prices are found for each construction item in terms of labor and material costs, and the final cost of the project is summarized (11:II-2). For example, the time needed to complete a detailed cost estimate for a $2,000,000 building is approximately three weeks (15:1).

The purpose of this research is to identify several factors which influence construction costs at Air Force bases and to develop an estimating procedure to incorporate the factors and reduce the amount of preparation time an estimator spends creating a cost estimate. The final result is an estimating method which may be used by the estimator to furnish to the contracting officer an accurate total cost for a project with less preparation time.

Research Objectives

The objectives of this research were established as follows:

1. To analyze the Air Force Civil Engineering design system and determine what factors effect the costs of construction on Air Force bases.
2. To determine how estimates are currently developed at base level.

3. To develop criteria to measure estimating system quality.

4. To develop an improved estimating system.

Research Questions

In order to meet the research objectives, the following research questions were considered:

Objective 1:

1. What estimating factors influence the cost of Air Force construction projects?
2. What cost percentage increase or decrease do the factors have on Air Force project costs?

Objective 2:

3. What estimating data bases are currently being used at base level?
4. What is the accuracy of the estimating systems currently in use?
5. What are the current procedures that estimators use to develop cost estimates?
6. How much time is being spent developing cost estimates?

Objective 3:

7. What major items need to be included as part of the data base to develop an accurate estimate?
8. What major factors affect estimating system usability?

Objective 4:

9. How does the proposed system implement the findings of this research?
10. How does the proposed system compare with existing systems using established criteria?

II. Background and Literature Review

Background and Literature Review

For Air Force weapon system facilities the prime contractor is usually responsible for developing cost estimates (11:I-2). This research does not consider weapon systems facilities. Air Force estimates of non weapon system facilities costs are prepared by Air Force base civil engineers, Air Force Regional Civil Engineers (AFRCE) or architect/engineer (A/E) firms under contracts awarded by the U. S. Army Corps of Engineers (COE) or the Naval Facilities Engineering Command (NAVFAC) (11:I-2). Congress has designated the COE and NAVFAC as design and construction agents for the Air Force Military Construction Program (MCP). A construction project may be designated as a MCP project in one of two ways: an unspecified MCP project or as a specified MCP project (4:17). An unspecified MCP project is a minor construction project less than $1,000,000 (4:8). A specified MCP project is a minor construction project over $1,000,000. Table I lists the unspecified minor construction levels and the specified construction level along with the appropriate approval levels (4:17).

TABLE I

Unspecified and Specified Minor Construction Approval Levels

	Unspecified Minor Construction		Specified Minor Construction
Estimated Cost	$200,000	$500,000	$1,000,000 and up
Approval Authority	USAF/LEE	SAF/MII	Congress

TABLE II

Base Level Projects and Major Command Approval Levels

Type of Project	Estimated Cost	Approval Level
Maintenance	Unlimited	MAJCOM/CC
Repair	$0 - $3,000,000	MAJCOM/CC
Minor Construction	$0 - $200,000	MAJCOM/CC

The types of projects completed at base level include maintenance projects, repair projects, and minor construction projects (10:8). Table II lists the three types of projects designed at base level and the major command approval levels (10:14). The approval levels delegated to base level may differ among major commands. This research deals with cost estimates prepared at base level by base civil engineers.

Base Level Funding Cycle. The base level funding cycle requires estimates to be developed and updated at several points during the design phase. Construction cost estimates are required throughout project development. Cost estimate development and use changes at different stages in the design process. The three major stages are the concept stage, preliminary stage , and the final estimate at 100% design (11:I-2). During the concept stage project budget estimates are prepared based on an overall comparison with the cost of similar, size and type, projects (15:1-5). The budget estimate is used for initial project funding. During the concept and preliminary stages, when comparative pricing methods are used, the total price for a facility may be determined to be too high. It is possible for elements of the building program to be responsible for excessive costs. The scope of the project and its functional areas may be excessive or the quality of building materials too

high. As a result the project may have to be cancelled because funds are not available for such a project (20:79). The project may be cancelled at this point in time with no design time spent on the project. During the preliminary stage the budget estimate is verified by comparing the estimate to other similar projects to be sure nothing has been left out of the estimate (15:1-5). The preliminary estimate may be completed during the initial submission of the project to the Engineering and Environmental Planning branch or just before the detailed design begins on the plans and specifications (15:1-5). During the design, construction costs should be made available to the designer. A good designer will integrate design decisions with a cost analysis of those decisions (20:79). Design in itself sets the costs for a project. Once the design is set, little can be done to influence the costs except to redesign the project. The final estimate, proposed at 100 percent design, typically uses a range of detailed and comparison estimating techniques. The final estimate is used to furnish the contracting officer a detailed cost estimate as required by the FAR (15:1-5). The final estimate is used to verify bid price resonableness (6:14-16).

Each estimating stage provides more detail about the project and estimates should be more technically accurate than the previous estimates. However, past experience in private industry indicates that early budget estimates are more accurate than design development (60% - 100% design) estimates (11:I-2). The early budget estimates in industry corresponds to the concept stage in the base level funding cycle (15:1-5).

Estimating Methods. There are many estimating methods available to the estimator for developing a cost estimate. Because methods vary, "consensus does not exist regarding the data base content, project

descriptors, algorithms, and achievable accuracy" (11:I-3). Generally, the estimating methods can be grouped into three broad categories: comparatives, such as the Air Force Pricing Guide; parametrics, such as those used in the aerospace industry; and quantity take-off, often used by construction contractors for bid preparation (11:II-1).

Comparative methods are used primarily for budget purposes and as a check of estimates developed using the quantity take-off (11:II-1). Comparative methods relate a proposed project to the cost of a completed project for which the total price is known (11:II-1).

The parametric method describes relations between parameters and costs using advanced mathematics (11:II-2). Most of these methods utilize complex computer programs to generate total costs. For example, parametrics are used to describe the relationships of interior partitions to the floor area or exterior skin surface to the height of the building to develop approximate quantities of materials for input into the cost estimate (3:II-2).

The quantity take-off method requires a detailed take-off of quantities obtained from plans and specifications. The take-off consists of measuring or calculating quantities of specified items used in the project. Prices are obtained for each item and multiplied by the quantity to determine the cost. The labor price is also obtained for each item and multiplied by the quantity to extend the labor costs. The costs are summarized to form a basic construction cost estimate (11:II-2). In general, a quantity take-off construction estimate is developed in three interlocking parts; performing the quantity take-off, pricing the items noted during the take-off, and calculating sub-contracted items (13:1).

Developing an accurate cost estimate is a demanding task. There are

many estimating procedures available for the estimator to use but estimating is not an exact science. Any group of estimators using the same procedure will still develop different costs for a project. A good estimator has the ability to measure quantities accurately and to gauge costs (13:1). A good estimate is built around a good set of quantities and a "proper feeling for cost, rather than being a by-product of statistics" (13:1).

Comparative and Parametric Cost. Most conceptual and preliminary design stage estimates are comparative estimates, parametric estimates, or some combination of the two. In addition to the direct project-to-project comparisons already discussed, important comparison techniques include: time-referenced cost indices, cost-capacity factors, and component ratios. Parameter cost estimates may use a wide variety of project physical and/or performace characteristics in cost estimation (2:179).

Time-referenced cost indices show changes in cost over time, based on an established reference period. Some types also reflect changes in technology, methods, and productivity as well as inflationary trends (2:179). Many of these indices are published along with the estimating books from several vendors. The "Quarterly Cost Roundup," published by the Engineering News-Record, lists over a dozen of these indices (13:179).

Before applying cost indices, it is important to know how they were derived. One approach periodically reprices and totals a constant package of resources that serve as input to a typical construction project (2:179). The index is computed by dividing this cost for a stated period by the cost of the resources in a base reference period (2:179). Another approach to derive cost indices is based on the cost of a completed project or a survey of selected components of completed projects (2:180).

There are obvious limitations if the proportions of the input components in an input-type cost index do not reflect the resources used on a particular project. Other limitations include productivity differences, changes in technology, and competitiveness of contractors (2:180). For the reasons just mentioned the estimator must be careful when selecting an index to use on a project. Properly applied however, indices can yield accuracies within 20 to 30 percent of actual costs (2:181). Because of the limited accuracy, the use of indices should be limited to the concept estimate only and not used to calculate final costs.

The cost-capacity factors may be used to consider changes in size, scope, or capacity of projects of similar types (2:181). The cost-capacity factor is expressed by the following exponential equation (2:181):

$$A = B\ (C/D)^X$$

where A = estimated cost of a new facility of capacity C

B = known cost of facility of capacity D

C = capacity of proposed facility

D = capacity of existing facility

X = the cost-capacity factor for this type of work

Table III shows several examples of cost-capacity factors that can be used in the above equation (23:16-18). The capacity represented by C and D are some parameter that reasonable reflects the size of the facility (2:181). For example, a warehouse might have the gross floor area as a measure of capacity (2:181). The cost-capacity method assumes an estimate or actual cost information already exists for a similar project. For example, an existing warehouse was built for $4,200,000. The size of the warehouse

TABLE III

Cost-Capacity Factors (23:16-18)

Process	Capacity	Unit	Cost-Capacity Factor	Capacity Range
Acetylene	10	Tons/day	0.73	3.5 - 250
Aluminum	100M	Metric	0.76	20M - 200M
Butadiene	10M	Tons/year	0.65	5M - 300M
Carbon black	1	Ton/day	0.53	1 - 150
Hydrogen	10MM	Cu ft/day	0.64	500M - 10MM
Oxygen	100	Tons/day	0.72	1 - 1.5M
Power plants, coal	100	Mw(elec)	0.88	100 - 1M
Urea	250	Tons/day	0.20	250 - 500

was 120,000 square feet. A new design for a warehouse of 150,000 square feet is developed and the cost estimate is derived using the cost-capacity factor for a warehouse. Assuming a cost-capacity factor of 0.8 for a warehouse the formula for computing the cost is (2:182):

$$A = B\ (C/D)^X$$

$$A = \$4{,}200{,}000\ (150{,}000/120{,}000)^{0.8}$$

$$= \$5{,}020{,}000$$

The use of the cost-capacity factors should also be limited to concept estimates only (2:183). The factors give an idea of the order of magnitude cost on a project. Accuracy depends largely on how well documented the records are that supported factor development. Estimates based on cost-capacity factors frequently vary 15 to 20 percent from actual costs (2:183).

Component ratios include equipment cost ratios and plant cost ratios (2:183). As the design progresses more information about size and type of items included in the project are known. Component ratios are used to

adjust previous estimates where the size and type of equipment may have been unknown. The equipment cost is multipled by an empirically documented factor to estimate the installation cost of that equipment (2:183). This approach allows the estimator to apply a more detailed level of judgement to an estimate and produce greater accuracy (2:186).

Parameter costs are the most commonly used in building construction (2:186). In the construction industry parameter cost estimating relates all costs associated with a project to just a few major components or parameters. For example, the total square footage of a typical building would be used to express all costs for that particular building. The cost would not be expressed in terms of individual unit prices, such as $0.12 per square foot for masonry (2:186). A parameter estimate requires at least schematic drawings for computing parameters (2:186).

During the conceptual or preliminary stages of a construction project comparative and parametric type estimates are completed for the project. Initially these types of estimates tell the owner or user if the scope of the project is anywhere near to being economically feasible. Once the project is under design, the preliminary estimates are continually revised to incorporate new information and keep the estimate or budget up to date. This in turn provides feedback to design to keep the overall project within budget (2:179).

Detailed Cost Estimating Techniques. As design progresses, comparison and parametric cost estimates are generally supplemented by detailed estimates. The detailed construction cost estimates may be divided into two types: the fair-cost estimate and the contractor's bid estimate (2:187-192). Both estimates are prepared from actual bid documents. The major differences between the two are the absence of

lump-sum subcontract quotations and a somewhat simplified number of line numbers in the fair-cost estimate (2:187). The government estimate prepared before bid opening is a fair-cost estimate. The fair-cost estimate is compared with the contractor bids at bid opening. If a wide discrepancy is noted between bids and the fair-cost estimate, the estimate details are compared to isolate the reasons for the difference.

Detailed cost estimates are made by applying unit costs to the quantities of those primary activities required to complete the project (21:3). Every detailed construction estimate or final cost estimate is based on a quantity survey, sometimes called the quantity take-off (13:6). The quantity survey is the best method to determine costs for a particular project (16:10). "This is the method used by contractors, subcontractors, material suppliers, and anyone else who needs or wants a complete cost figure, that is as accurate as possible" (16:10).

Before starting the take-off, the estimator must examine the drawings for an idea of the layout, type of building, number of floors, and general design (13:7). There are three basic rules for taking off quantities: measure everything as it shows, take off everything that can be seen, and if the item is different, keep it separate (15:8). During the take-off several different items will be found within the same specification division. For example, concrete will typically include reinforcing steel, anchor bolts and equipment items. Even though the items are found in the same specification division, they should be kept separate. Keeping these rules in mind while preparing a detailed cost estimate will save time overall.

A detailed material quantity take-off should be undertaken when the construction documents are 50 to 95 percent complete (20:112). Before the

TABLE IV

Uniform Construction Index Format

Division	Title	Division	Title
1	General Requirements	9	Finishes
2	Site Work	10	Specialties
3	Concrete	11	Equipment
4	Masonry	12	Furnishings
5	Metals	13	Special Construction
6	Wood and Plastic	14	Conveying Systems
7	Thermal and Moisture Protection	15	Mechanical
8	Doors and Windows	16	Electrical

quantity take-off can be started, a portion of the plans and specifications must be complete. As the plans and specifications progress so should the estimate. However, completing the estimate as the design progresses could cause the estimator to reaccomplish a portion of the estimate if redesign of a portion of the project was necessary. As the design progresses the detail of the estimate also progresses until the final cost estimate represents all items included in the total project. The detailed estimate is very accurate and also serves as a check against the reasonableness of the contractor's bid and to verify payments (20:113).

The form of the detailed cost estimate usually is based on the Uniform Construction Index (UCI) format for cost analysis (20:113). The UCI cost analysis follows the 16 subdivisions of the specifications listed in table IV.

The accuracy of the detailed estimate depends on the accuracy of the quantity take-off, the accuracy of the extensions, and in the selection of the unit costs (21:3). "Any assessment of the accuracy of cost prediction methods must ultimately rely upon quantitive techniques..." (1:4). Even when the quantity take-off and extension operations are properly performed

by the estimator, cost estimate errors may result because of an unreliable data base. One reason for unreliable data bases is the lack of documentation in the construction industry. Even during the construction process, difficulties are encountered for accurately recording expenditures (1:4). Also, contractors are often reluctant to reveal profit levels (1:4). The result may be a detailed data base of unreliable information.

The percentage of accuracy is also related to the progress of design (20:85). At the end of the programming phase, the cost estimate should predict project cost accurate to plus/minus 12 to 13 percent (20:85). Using the comparison or parametric types of estimates should be expected to predict project costs of plus/minus 15 to 30 percent. But local factors must be considered to reflect the total costs of the project as close as possible. These local factors will be discussed later under the heading of estimating factors. The programming phase is equivalent to the concept stage of a base level project. At the end of the schematic phase, 35 percent design phase, an allowance of seven to eight percent should be made for design contingencies (20:85). At the end of the design phase a five percent contingency is used and just before the final documents are sent to bidders a detailed construction estimate is made to include market conditions at the time of bidding. This procedure should allow for an accuracy of one to two points of the low bid (20:85). Contractors should be able to estimate costs within plus/minus five percent of final project costs (1:4).

Estimating Systems

There are a number of estimating systems utilizing one or more of

these estimating methods. Different systems may use different estimating bases. Data base development and use also differs between estimating systems.

Dodge Computer-Aided Estimating Systems. The Dodge system offers three levels of estimates: The conceptual estimate called System 90, the prelimiminary estimate called System 73, and the detailed estimate called System 1 (8:92). The data base is comprised of more than 12,000 building components, labor rates, and productivity figures (8:92). The costs are associated with zip codes for 620 locations in the U.S. and Canada (8:92). The programs are easy to run and are easily accessible via a time-share network. The programs are proprietary and system cost to the customer is based on the amount of customer use.

Component prices are generated from field data for materials and labor costs (11:II-13). The advantages of using this data is that it is well maintained and documented (11:II-14). However, one major disadvantage of using the Dodge data base is that different areas in the data base are multiplied by various modifiers. The modifiers are not explained to the estimator and the material prices "...are not documented at this level" (11:II-14) and pose a problem since the modifiers are unknown.

Computer Aided Cost Estimating System (CACES). The product of CACES is a quantity take-off type estimate (11:II-4). CACES is a Corps of Engineers computer program utilizing a very extensive data base. This type of estimate is very detailed and prices and man-hours are very accurate. The advantages of CACES are the detail generated by the program and "the application of shipping rates and listing of all construction equipment, personnel, and contractor general condition items" (11:II-4).

The major disadvantage of CACES is the expertise needed by the estimator to input data and lack of flexibility in the formats of the program (11:II-4). Another disadvantage is the requirement for updating the extensive data base.

Means Construction Cost Data Service. The R. S. Means company publishes several separate pricing guides. Three of the guides in use today include the Building Construction Cost Data, Repair and Remodeling Data, and Systems Costs. The information contained in the pricing guides includes component prices, basic labor rates, and assembled prices (17:IV). The pricing guides are based on unmodified national averaged costs, exclusive of overhead, profit, subcontractor markup and contingencies.

The data within the guides are very well organized. The estimator has complete freedom in picking a price and knowing exactly what is included in the price. Means claims no accuracy using the data, but states the data are correct (8:241).

McAuto's Estek Construction Estimating System. The Means data base is also used in McAuto's Estek Construction Estimating System (11:II-8). The cost estimate produced by the Estek System is a detailed quantity take-off type estimate (11:II-8). The user has access to the system either through a batch or on-line data link. The advantages of using the Estek System are the "great documentation, ease of use for typical buildings, labor savings through the use of a decision matrix, easy modification and consistent system processing" (11:II-9). Disadvantages include the lack of modifiers for escalation and possible data base inconsistencies (11:II-9).

Richardson Rapid Construction Cost Estimating System. The

Richardson system is mainly used to estimate final bid costs. The system is very detailed. The data includes both costs and installation man-hours for each equipment item. The costs contained within the data base are obtained from vendors (8:255).

Also included in the Richardson data are quarterly updates called the Cost Trend Reporter which contains information on crafts, materials, and labor (18:1). Wage factors are included in two of the Cost Trend Reporter's four issues (8:255). The data are constantly being updated throughout the year and revisions are sent to subscribers.

The accuracy of the Richardson data is questionable. Mistakes have been found, for example, "cooling tower costs are very low" (8:257). As a result, estimators must often double check the costs for a particular item if the cost seems too low or too high.

Berger Building and Design Cost File. The Berger Building and Design Cost Files are published in two volumes. Volume I is general construction trades and Volume II is mechanical and electrical trades. Within each volume are three parts. The user has the option to apply either the unit costs as shown in Part I or the system costs in Part III (3:VII). Part II contains several estimating tables the user can use to prepare an estimate (3:XI).

The cost data in the Berger Cost Files are derived from the experience of actual contractors working on the job (3:XIV). The costs associated with each item are considered both practical and current. However, in actual practice contractors performing work in the same city will experience varying costs for the same item throughout the year (3:XIII). The Berger Cost File presumes average rather than optimum conditions and the estimator must adjust the costs as necessary (3:XIII).

The Berger Cost Files contains an excellent introduction on how to use the volumes and an explanation on how costs are derived. It is very easy for the user to create an estimate based on either the book costs or revised costs. The various factors and percentages explained in these volumes are excellent sources for determining detail costs.

Estimating Factors. Even with these established and accepted estimating systems, there is still a need to add additional factors to adjust the final cost (16:II). These include contractor's indirect charges, overhead costs, and costs associated with location of work, work conditions, inflation, and other unique conditions. The estimator must identify and take into account all the factors affecting a particular construction project. Each project will have different factors affecting costs either positively or negatively and the estimator must know what to do with the factors.

Fixed and Variable Overhead. There are two principal types of overhead: "permanent or fixed items relating to the cost of maintaining a business, and variable costs that fluctuate with each project" (16:12).

Every business has a fixed overhead cost just to keep the business running. The types of costs associated with fixed overhead are not related to the performance of any one job. General overhead includes owner's salary, home office expenses, depreciation, business taxes, and professional licenses (21:65). Total cost for these fixed overhead costs may be calculated on a yearly basis and then charged to each project on a cost-of-construction percentage (16:12).

The overhead costs charged for a particular job depend on the contractor's total volume of work during the course of a year. The contractor normally has no way to accurately predict what volume of

business will actually be awarded to him. This problem is common to all businesses but perhaps more severe in the construction industry because "the sizes of the jobs bid vary greatly, the number of jobs awarded per year is relatively small, and a difference of one job of average size will often result in a significant variation in the volume of work done during the year" (21:65).

In the building construction industry the general contractor normally does about 25 to 30 percent of the work with his own forces (21:67). As a general rule 25 percent of the total bare cost of the general contractor's own work is added to account for fixed overhead costs (21:67). Bare costs are costs pertaining only to the work item. No overhead and profit is included in the bare cost for an item of work. Two other rules of thumb may be used to estimate fixed overhead costs: take 40 percent of the total labor costs for the general contractor's own forces, or take 5 to 7 percent of the estimated bare cost of the total job (21:67).

Variable costs, sometimes called direct job overhead or general conditions, are those costs associated with running a particular construction job. Items included as variable costs are contract bonds, insurance, supervision and job office salaries, utilities, access roads, and clean up (13:173). Many of the variable cost items could be included as fixed overhead or as part of the individual trade costs. The estimator can add overhead costs to the project as an individual item of work or as a percentage of the total project cost. As long as all the cost items are included in the estimate, the allocation of costs as either fixed overhead or as part of the trade costs does not really matter (13:171).

Bonds. For government jobs most contractor's are required to submit a bid bond and a performance bond. The bid bond is a guarantee the

TABLE V

Performance Bond Premiums (17:322)

Bid Amount	Bond Premium
Less than $500,000	$12.00 per thousand
500,000 to 2,500,000	$6,000 plus $7.25 per thousand
2,500,000 to 5,000,000	$20,500 plus $5.75 per thousand
5,000,000 to 7,500,000	$34,875 plus $5.25 per thousand
over 7,500,000	$48,000 plus $4.80 per thousand

contractor will enter into the contract with the owner (government) at the established bid price if awarded the job (21:12). Bid bonds are addressed to the owner, signed by the contractor and by the bonding company, and are normally in the amount of 10 percent of the amount bid (21:12). If the contractor refuses to enter into a contract at the bid amount the bid bond is forfeited to the owner. Bid bond costs are relatively small. Typically only a few dollars per year (13:173).

The performance bond guarantees the performance of all work required to complete the contract (13:172). The premiums for performance bonds vary according to the job price. An example of performance bond premiums are listed in table V (17:332). Using the cost structure in table V, an estimated construction cost of $2,650,000 would have a performance bond cost of $20,500 + (2,650,000 - 2,500,000)(5.75) = $21,362.50. A surcharge of one percent of the regular premium is typically made for each month of job duration in excess of 24 months (18:332). The minumum bond premium is currently $25.00 (20:13).

Insurance. There are several types of insurance the contractor may be responsible for during the construction of a project. Insurance includes workmen's compensation, public liability, and builders risk

TABLE VI

Workmen's Compensation Percentages (17:335)

Trade	Insurance Rate (percent of labor cost) Range	Average
Excavation, Grading, etc	1.6 to 27.8	6.9
Piles and Foundations	3.5 to 44.3	17.2
Concrete	1.8 to 27.1	8.5
Masonry	1.4 to 20.8	7.1
Sturctural Steel	3.5 to 47.8	19.5
Miscellaneous and Ornamental Metals	1.2 to 15.7	6.7
Carpentry and Millwork	2.4 to 54.1	9.4
Metal or Composition Siding	2.2 to 16.6	7.3
Roofing	4.1 to 52.7	16.3
Doors and Hardware	1.4 to 15.9	5.4
Sash and Glazing	2.5 to 33.3	7.5
Lath and Plaster	1.6 to 22.9	6.9
Tile, Marble and Floors	1.0 to 29.6	5.2
Acoustical Ceilings	1.2 to 15.4	5.4
Painting	2.0 to 16.6	7.1
Interior Partitions	2.0 to 54.1	9.4
Miscellaneous Items	1.1 to 54.9	8.3
Elevators	1.5 to 15.6	5.1
Sprinklers	1.2 to 17.0	5.7
Plumbing	1.2 to 12.5	4.7
Heat., Vent., and Air Conditioning	1.7 to 13.5	6.0
Electrical	1.1 to 13.1	3.9

insurance (13:173). The rates for workmen's compensation vary according to the trades involved and the state where the work is being completed (13:173). Workmen's compensation insurance has increased drastically in the past few years and now represents a major portion of the payroll expenses (21:60). Table VI provides information on workmen's compensation percentage by trade classification and the average percentage markup used on labor costs (17:335). Included in some of the more detailed cost estimating books is a table showing workmen's compensation rates by state and trade classification. For example, the R. S. Means book lists 22 trade classifications in each of the United States and 12 districts in

Canada (17:335). The percentages can be applied to each trade as appropriate or an overall weighted average of 9.03 percent may be applied to the total labor costs for a project (17:335).

Public liability and builders risk insurance does vary but not to any great extent. The combined markup for public liability and builders risk ranges from 1.2 percent (17:333) to 2.8 percent (15:61) of the labor costs.

Fringe Benefits. Fringe benefits paid to workers include contributions to funds for health insurance, vacations, pensions, welfare plans, and numerous others (2:200). The estimator must determine what craft agreements are used in a particular location and the timing of the work in order to price fringe benefits (2:200). Many cost estimating books currently include the fringe benefits in the base price so separate calculations are not needed. However, the estimator must be aware of local labor unions and restrictive union practices which effect the benefits a worker may receive (13:175).

Government Payroll Taxes. Payroll taxes include federal social security taxes, federal unemployment taxes, and state unemployment taxes (21:59). Federal unemployment taxes, and state unemployment taxes are withheld from the employee's earnings, but unlike social security tax, there is no matching employer's contribution (2:200). Only the portion of the social security tax which is paid by the employer is considered in determining the allowance for payroll expenses (21:59). The amount used to mark up wages for social security taxes is seven percent of the wages up to $37,800 (17:333).

Some unemployment tax ranges vary from state to state. Some states even vary the local amounts from 1.6 percent to 5.4 percent plus a 1 percent solvency tax (17:333). State and federal unemployment taxes

TABLE VII

Sales Tax Percentages (17:338)

State	Tax	State	Tax
Alabama	4	Montana	0
Alaska	0	Nebraska	4
Arizona	5	Nevada	5.75
Arkansas	3	New Hampshire	0
California	4.75	New Jersey	6
Colorado	3.5	New Mexico	3.75
Connecticut	7.5	New York	4
Delaware	0	North Carolina	3
District of Columbia	6	North Dakota	4
Florida	5	Ohio	5
Georgia	3	Oklahoma	2
Hawaii	4	Oregon	0
Idaho	4.5	Pennsylvania	6
Illinois	4	Rhode Island	6
Indiana	5	South Carolina	4
Iowa	4	South Dakota	4
Kansas	3	Tennessee	4.5
Kentucky	5	Texas	4
Louisiana	3	Utah	4.125
Maine	5	Vermont	4
Maryland	5	Virginia	3
Massachusetts	5	Washington	6.5
Michigan	4	West Virginia	5
Minnesota	6	Wisconsin	5
Mississippi	5	Wyoming	3
Missouri	4.125		

together make up three to seven percent of the first $7000 of wages (17:333). The federal tax rate is 3.5 percent (17:333).

Material Taxes. Sales tax on material varies from state to state and city to city. Table VII lists the state sales tax only for each of the 50 states and the District of Columbia (17:338). In addition to state sales tax the estimator must include local city and county taxes. The percent markup is applied only to the material costs for a project. In some states and localities, ordinances may exempt sales tax on materials. When exempted, such costs need not be considered (15:4-1).

However in some cases, when a contractor is working for the Government and the contractor purchases the building supplies the contractor may have to pay taxes on the supplies bought (6:29-2).

Profit. Every business expects to make a profit. Determining the amount of profit to apply to a construction project is a difficult task. If a business cannot return a profit on money invested in a construction project greater than the interest that may be obtained by putting money in the bank, there should not be a business investment (16:13). Some of the estimating books will automatically assume a 15 to 25 percent profit when calculating total costs for an item (16:13). Other estimating books assume a 10 percent profit margin (17:334).

As with most businesses, the contractor will have times when work is scarce and times when work is plentiful. The contractor may feel a higher profit can be earned when work is plentiful (16:13). When work is slow the contractor may take a job at near cost just to keep the business known and the employees working (16:13).

All of the factors discussed above are included in table VIII. These factors must be added to all construction cost estimates. The following factors need only be considered for a project and are not necessarily included in all construction cost estimates.

Wage Premiums. Wage premiums such as overtime, shift-work differentials, and hazardous work need to be considered by the estimator (2:201). The phasing of a project or the completion time of a project may require the contractor to work in shifts or to work overtime to complete the job. The estimator must be aware of these increases in order to develop an accurate cost estimate. The Contract Work Hours and Safety Standards Act requires a contractor to pay overtime at a minimum of time

TABLE VIII

Factors to Add to Project Costs

Cost Factor	Amount to Add to Project
Fixed Overhead	25% of total bare costs
Performance Bonds	min $25.00 (see table V)
Insurance	
Workers Compensation	avg 9.03% of labor cost (see table VI)
Public Liability and Builders Risk	1.2% - 2.8% of labor cost
Social Security (FICA)	7% of labor cost
Unemployment Tax	avg 3.6% of labor cost
Material Tax	0 - 7.5% of material cost (see table VII)
Profit	10% - 25% of total bare cost

and half (14:2). Overtime is now defined on a 40 hour weekly basis and not an eight hour day basis (14:2). However, overtime is increasingly paid at double time, and in some cases, especially on holidays, at triple time (2:201). Ordinarily, overtime is based on a 40-hour, 5-day week, but in some areas electricians have been paid overtime for work in excess of a 25-hour week (2:201).

There are several ways of paying for shift-work differentials. One way is to pay a different percentage of the base wage to the afternoon shift and the graveyard shift. Another common method used in the western states is to give 8-hours' pay for the first 7 or 7 1/2 hours work, and overtime thereafter (2:202).

Premiums for hazardous type work are usually based on a fixed increase over the base wage rate (2:202). The types of workers associated with this type of pay are masons working over 25 feet above the ground, electricians working underground, and crane operators when the boom is over 185 feet long (2:202). These premiums could also be adjusted further

for overtime work or shift-work differential.

Labor Productivity. Productivity is much more difficult for the estimator to determine. Many of the factors influencing labor productivity are highly qualitative, and a great deal of experience and judgement is needed to develop the qualitative information (2:202).

There are a number of factors which affect productivity. One of the factors is related to the amount of other work the contractor has at the time the proposed project is awarded (22:165). When a project is nearing completion and the craft workers sense the contractor has not been awarded a new project, there may be a tendency for the workers to slow down (22:165). This is especially true for workers who have not previously worked for the contractor (22:165). The government estimator must be aware of who the bidders might be on a project and determine if the labor force in the area is adequate to support a new construction project.

Regional variations in training, experience, and skill of the labor force along with the work rules which are negotiated between employers and unions can affect productivity (2:203). "These factors can cause productivity in some parts of the country to be more than double that in others" (2:203). A craft worker can be experienced in one portion of a trade and inexperienced in another portion (22:167). For example, a plumber who has worked exclusively on power plants would likely be inexperienced if employed on a high-rise apartment building (22:167). Although the estimator cannot forecast which craftsmen will work on a particular project, an overall survey of the local work force can be used to estimate the approximate skill level available.

The environmental conditions also affect productivity levels. Weather conditions have a strong effect on the labor costs of a project

(22:166). The physical locations and working conditions of individual craftsmen can also influence productivity (2:204). When the temperature is extremely low, the performance of manual workers is inhibited (22:166). The height above grade of the work station, restricted work access, dust and other factors influence worker productivity. A good estimator will preplan when these activities will take place to minimize the impact on costs. Careful scheduling of outdoor activities can reduce weather effects, as can the appropriate use of enclosures and layout of construction facilities (2:204).

The productivity of craft workers is impeded by inaccurate and incomplete drawings or specifications (22:167). The skilled workers of a contractor need accurate drawings to perform their work assignments. If a discrepancy is found a clarification is needed before work can proceed. Usually the craft worker will be requested by the contractor to stop work until the matter is resolved (22:167). The contractor may disagree with the contracting officer interpretation and perform the work under protest which could eventually lead to litigation. While completing the final estimate the government estimator should look for discrepancies and ask for clarifications from the designers.

Table IX lists the factors to consider for each project. The percentage increase or decrease to apply to the estimate is left up to the estimator.

Cost estimating can achieve 80 to 90 percent of the total costs when dealing only with measurable quantities described in the drawings and specifications, but market conditions exist in the economy over which no control the estimator has, only informed forecasting (20:85). These market conditions include: inflation or escalation, time of year the

TABLE IX

Factors to Consider for Each Project

Cost Factor	Considerations
Wage Premiums	Overtime
	Shiftwork
	Hazardous Work
	Phasing of Work
Labor Productivity	Amount of Work Available
	Training
	Experience
	Skill of Labor Force
Environmental Conditions	Weather
	Physical Working Conditions
Plans and Specifications	Accurate
	Complete

award of the project takes place, bidding load on other projects in the area, labor supply in the local area, union shop versus open shop, material shortages, and the competitive climate of the bidders (20:85). The cost estimate must include these items to be as accurate as possible. When included in the estimate the accuracy of the final estimate should be within a point or two of the low bid (20:86).

Summary

In summary, there are many estimating systems for the estimator to use to estimate costs for a construction project. During the initial programming phases of a project the comparison or parametric type estimating methods may be used with an expected accuracy of plus/minus 20 percent of the bid price. During the final phase of design, the detailed quantity take-off method may be used to estimate construction cost to within one or two percentage points of the bid price when local economic conditions are considered.

TABLE X

Disadvantages of Various Estimating Systems

Data Base	Major Disadvantages
Dodge	modifiers not explained material prices not documented
CACES	expertise to run the system lack of flexibility in formats updating extensive data base
Estek	lack of modifiers for escalation data base inconsistency
Richardson	mistakes in the data base

Each estimating system or procedure has its own advantages and disadvantages. The disadvantages are of particular concern for the research described in Chapter 3. The major disadvantages associated with the estimating systems researched for this thesis are listed in table X.

In addition to the various estimating systems, the Literature Review considered the need to adjust the cost of a construction project by considering certain additional factors. These additional factors are summarized in table VIII. These factors must be added to all types of construction projects. The estimating procedure proposed by this research will include the factors shown in table VIII and identify other factors peculiar only to Air Force projects. The factors peculiar to Air Force construction projects include work located inside an aircraft alert area, work located on the runway, work located on the ramp area, work located inside a weapon storage area, competition amoung bidders, and remote site location. These factors are based on the authors three years experience working in the design section at base level and one year experience working with a civilian Architect/Engineer firm and four years teaching the Construction Cost Estimating course at the School of Civil Engineering

at Wright-Patterson Air Force Base, Ohio. Other factors which an estimator must consider are listed in table IX. These factors have no standard percentage increase or decrease on project costs but should be considered by the estimator.

III. Methodology

The purpose of this chapter is to develop the methodology used to answer each research question. First, the data base for this research will be discussed under the header of sample population. Also included in the data base discussion is a description of the questionaire used to gather data and a description of the interview procedure. The second portion of this chapter describes how each objective and related research questions will be analyzed. This section will describe which questions on the questionaire relate to the research questions and how the interview was used to help define some of the research questions.

Sample Population-

The population for this research was all base level Civil Engineering design sections. The design section was choosen because this section completes the final cost estimate to be used by the contracting officer as the government estimate. A questionaire was distributed to students in the ENG400, Construction Cost Estimating course at the School of Civil Engineering, to determine base level Civil Engineering design section views on estimating. The time period the questionaires were distributed covered from July 1985 to February 1986. The students were from overseas and continental United States Air Force Bases. The respondents were base level designers and engineers holding a 552X Air Force Specialty Code (AFSC) and civilian equivalent. All respondents had experience in the design section and experience estimating construction projects.

The questionaire focused on estimating procedures currently in use and the various factors affecting the total cost for a particular project at base level. Also, the survey was used to determine if an existing data

base such as the Means "Construction Cost Data Files", Richardson "General Construction Estimating Standards", etc. was being used and how accurate these costs are for Air Force construction projects. A sample questionaire is located in Appendix A.

An interview was also conducted at base level to determine what types of projects are completed in a typical year. Two Air Force Bases were used for the interviews. This was done to include 100 percent of the designers at each base and get their responses on how many projects they complete in a one year time frame. Each interview consisted of asking respondents from the base civil engineering section how many projects over the past year could be catergorized as complex designs, standard designs, repetitive designs, or Architect/Engineer designs. A complex design is defined as developing original drawings and specifications for a one-of-kind project. Standard design is defined as developing drawings and specifications for a basic facility. Standard design projects contain no unusual design features. Repetitive designs are those where an existing project can easily be modified to develop drawings and specifications. Architect/Engineer designs are projects where an Architect/Engineer under contract to the government designs the project. For Architect/Engineer designs, the Air Force designer only monitors and reviews design completion. The data from the interviews was used to define a typical work load and to help clarify how the time to complete an estimate could vary over a one year period. For example, a designer with more complex designs may spend more time completing estimates then a designer who had more standard designs. A sample of the interview check list is shown in table XI.

After all the data was collected and assembled the percentage of the

TABLE XI

Interview Check-List

Interview Check-List

Name:

Rank:

Title:

Organization:

Location:

Date:

How many projects have you completed over the past one year?
Complex Projects
Standard Projects
Repetitive Projects
Architect/Engineer Projects

Reasons why your cost estimates were too high or too low when compared to the bid price.

sample responding to each question was calculated based on the total sample size. The estimators at base level were also asked to provide the type of information they need to develop a cost estimate. This data is used to set up the computer data base for the estimating program. The data generated by the questionaires are located in Appendix B.

Research Objective One

Objective One. The first objective was to analyze the Air Force Civil Engineering design system and determine what factors effect the costs of construction on Air Force Bases. Specifically, what factors influence costs and what percentage increase or decrease do the factors have on Air Force project costs.

Research Question #1. What estimating factors influence the cost of Air Force projects? The questionaire listed 12 factors, questions 15 - 26, and space for other factors to be added if the respondents wished to identify any other factors that they used. Out of the 12 factors listed on the questionaire 6 factors were identified during the literature review. The six factors were hazardous work, shift work, overtime, skill of workers available for the project, weather during the construction period, and accuracy of the bidding documents. The other six factors were choosen based on the authors experience as directly relating to Air Force projects. These other factors were work located inside an aircraft alert area, work located on the runway, work located on the ramp area, work located inside a weapon storage area, competition among bidders, and remote site location. These factors were included to see if any estimator actually used the factors and if so what percentage increase or decrease the estimator used. The factors would be applied as a percentage of the total construction costs for a particular project.

In addition to the factors listed on the questionaire several basic factors were identified during the literature review. The basic factors are shown in Chapter 2, table VIII, with the appropriate amount to add to the cost of a construction project. The proposed estimating procedure will include the basic factors.

Research Question #2. What cost percentage increase or decrease do the factors have on Air Force costs? The respondents were asked to give a percentage increase of decrease for each of the 12 factors listed on the questionaire. The survey results would then be tabulated based on the average and the median values for each of the 12 factors.

Research Objective Two

Objective Two. The second objective was to determine how estimates are currently developed at base level. To meet the second objective a combination of the questionaire and personal interviews where conducted. The questionaire dealt with the types of data bases that were currently in use, question 4; the accuracy of the data base, questions 5 - 7; and how much time was being spent developing cost estimates, questions 8 - 11. The interview was used to define an average work load a designer might have during a typical year and to verify what estimating method was in use. The interviews were conducted within the design section at base level with designers who were currently involved in construction cost estimating.

Research Question #3. What estimating data base is currently being used at base level? Question 4 on the questionaire focused on six existing data bases identified in the literature review, an area where the respondent could indicate they created their own data base, and a place to indicate other data bases the respondents may have used. The average value was calculated for each response based on the sample size.

Research Question #4. What is the accuracy of the estimating system currently in use? The accuracy of the estimates was determined by three questions on the questionaire: Questions 5, 6 and 7. The responses were divided into three categories based on the total construction costs of projects. The categories were projects less than $200,000, greater than $200,000 but less than $500,000, and greater than $500,000. The purpose for dividing the responses into categories was to determine if the accuracy was affected by the size of the project. The categories followed the minor construction approval levels shown in Chapter 1, table I.

Research Question #5. What are the current procedures that estimators use to develop cost estimates? The estimating procedure used by the estimators was determined by the responses to what existing data base was being used, question 4 on the survey questionaire. Also the interviews conducted at base level were used to determine if another estimating system was available and if that system was being used.

Research Question #6. How much time is being spent developing cost estimates? The time spent preparing cost estimates was determined by questions 8, 9, 10, and 11 on the questionaire. The questions divided the responses into four categories based on total construction costs of projects. The categories were projects less than $200,000, greater than $200,000 but less than $500,000, greater than $500,000 but less than $1,000,000, and greater than $1,000,000. The average value for each response was calculated based on the sample size.

When all the values were calculated for the type of data base currently in use, the accuracy of the data base, and the time to complete an estimate a comparison between each data base and the accuracy was made. For example, the respondents who indicated they used R. S. Means would be compared to their responses on accuracy. The comparison was used to determine if any conclusions could be made about the accuracy of the existing data base. The time to complete an estimate was needed to compare the existing estimating system to the proposed system developed as part of this research.

Research Objective Three

Objective Three. The third objective was to develop criteria to measure the estimating system quality. The items addressed in the

objective included the major items in the data base that were needed to develop accurate costs and the major factors which affect the estimating system usability.

Research Question #7. What major items need to be included as part of the data base to develop an accurate estimate? The questionaire listed 13 items in questions 27 - 39 that many cost estimating books use in their description of a work item. The Berger Building and Design Cost Files, Richardson Rapid Construction Cost Estimating System, and the Building Construction Cost Data books are just a few examples where many of the items used on the questionaire can be found. Table XII shows a matrix of a few estimating books and the items used to describe a work item. Not every book will have all the items included in the description of an item of work. The 13 items used on the questionaire included description, crew, unit of measure, sub-contract item, material cost (without any mark-up), labor cost (without any mark-up), equipment cost (without any mark-up), total cost (without any mark-up), man-hours to complete the work item, material cost (with mark-up included), labor cost (with mark-up included), equipment cost (with mark-up included), and total cost (with mark-up included). The respondents were asked to rank order the list in order of importance (1 being the most important). The questionaire also had space available for any additional items the respondents wanted to add.

Before the results of the questionaire were known the data base for the new proposed system was developed. The items included in the data base were based on the authors experience in estimating which included three years at base level working in the design section, one year working for an Architect/Engineer firm, and four years of teaching and research in

TABLE XII

Major Items Included in Estimating Books

Estimating Method	Items Used to Describe a Work Item											
	Description	Crew	Unit of Measure	Sub-contract	Without Mark-up				With Mark-up			
					Mat	Labor	Equip	Total	Mat	Labor	Equip	Total
Berger Cost Files	X	X	X	-	X	X	X	X	-	-	-	-
Dodge Manual	X	X	X	-	X	X	X	X	-	-	-	-
Richardson	X	-	X	X	X	X	X	X	-	-	-	-
R. S. Means	X	X	X	-	X	X	X	X	-	-	-	X

cost estimating at the School of Civil Engineering at Wright-Patterson Air Force Base. The data base was needed immediately to test the estimating program and to solve any problems with the program for the proposed new system. The items included in the data base were: description, crew, unit of measure, material cost (without mark-up), labor costs (without mark-up), equipment cost (without mark-up), total cost (without mark-up), man-hours to complete the work item, and total cost (with mark-up included). These items were chosen because they do not have any mark-up included in the cost. The one exception was the total cost which is included without mark-up and with mark-up. This was done so that the author could double check costs. For example, when factors were introduced to the program the author could check if the factors were being applied to the correct costs when compared to the total cost with mark-up included.

The results of the questionaire were used to determine what the estimators wanted in the data base. The responses to each item were added together and then a ranking was applied based on the low total receiving a one ranking as the most important item. The process was continued until all items were put in a rank order from most important to least important. If a respondent added an additional item that was not included on the questionaire a special rank designation was to be given. For example, the respondent had already ranked the titles listed on the questionaire and determined a new title should be added. The respondent would list the title and give it a rank. The rank of the new title would be the number from the orginal ranking in which the new title would follow plus an alpha designation of A, B, C, etc.. A ranking of 2A means the new title would be ranked first after the original ranking of 2 from the list

on the questionaire.

Research Question #8. What major factors affect estimating system usability? The usability of the system was based on the literature review of existing systems. Table X, located in Chapter 2, lists several reasons why the existing estimating systems discussed in the literature review failed. The proposed system was designed to avoid some common mistakes found in other systems and to give the estimator freedom to change any portion of the data.

Research Objective Four

Objective Four. The fourth objective was to develop an improved estimating system by including as many items as the estimator needed to create a valid cost estimate. The information gathered from the estimators at base level was used to set up a computer data base and a computer estimating procedure. The data base format was determined by information the estimators need to complete a estimate. Once the format was set up on the computer the estimator then inputs all costs for items used at their particular base. This procedure allows for continuous updating and for a permanent data base to be established for any particular base. After the data base was completed the estimator can then run the estimate program for any project. The estimator inputs the quantities for the various items included in a project and the program calculates final costs. The program also informs the estimator what type of factors may be applied on a particular project and the average values to use. The factors were based on results from the survey and the estimator can determine whether to use the factors given in the program or input their own factors and values.

The accuracy of the estimate program was tested against several existing Air Force projects. A group of estimators using the estimate program developed a total estimated cost for the project. Another group of estimators completed the estimate using published data bases from several sources such as R. S. Means or Richardson. The costs were then compared with the actual costs of construction and the government estimate along with the time it took to prepare the computer estimate and the quantity take-off estimate.

Research Question #9. How does the proposed system implement the findings of this research? Based on the Literature Review and questionaire responses to questions 27 - 39 the data base format would be developed. In order to accomodate as many users of the system as possible the computer procedure must also be adaptable to each estimators inputs.

Research Question #10. How does the proposed system compare with existing systems using established criteria? The criteria for judging the new system includes the major disadvantages of existing systems shown in Chapter 2, table X. The new system will try to minimize the disadvantage by: 1) including various modifiers within the program, 2) keeping the data base and the procedure for running the program simple, 3) allowing the user to update costs, and 4) standardize the data base format. In addition to minimizing the disadvantages of existing systems the new system would be judged on accuracy and time to complete the estimate.

To validate the system three existing projects were chosen as case studies to compare the proposed estimating system with the existing method of completing construction cost estimates. The projects were chosen based upon interview comments for a typical design project. Another criteria

for chosing the projects was project size. Projects had to be small projects because the data base of the new system was not very extensive at the time of testing. In each case the existing cost estimate was available and a contractor bid was available to compare to the new estimating systems cost. The comparison of all three estimates would validate the accuracy of the proposed estimating system. In addition to comparing the estimates the man-hours to complete the government estimate and proposed system estimate was compared. The comparison of man-hours was used to validate the assumption that the proposed estimating procedure could develop accurate construction cost estimates in less time.

Since no time was available to train estimators on the use of the proposed system the author ran the proposed computer procedure on all three projects mentioned above.

IV. Findings

Sample Population

The sample size consisted of 112 base level designers and engineers located throughout the United States and overseas. The majority of respondents were GS-9's thru GS-12's and 1Lt's thru 2Lt's with an experience level ranging from less than 1 year to over 5 years. Tables XIII, XIV and XV lists the percent who responded to the first three questions on the questionaire.

TABLE XIII

Experience Level of Sample Population

Question 1. How many years of estimating experience do you have?

Percentage of Responses	Experience
29	Less than 1 year
22	Over 1 year but less than 2 years
9	Over 2 years but less than 3 years
8	Over 3 years but less than 4 years
5	Over 4 years but less than 5 years
26	Over 5 years
1	Non responsive

Research Objective One

Research objective one was to analyze the Air Force Civil Engineering design system and determine what factors effect the costs of construction on Air Force bases. To meet this objective two research questions were formulated.

Research Question #1. What estimating factors influence the costs of Air Force construction projects? Based on the questionaire results the factor which influence costs the most was related to work located on the

TABLE XIV

Location of Respondents in Sample Population

Question 2. What State is your base located in?

State	Number of Responses	State	Number of Responses
Alabama	0	Alaska	0
Arizona	1	Arkansas	2
California	12	Colorado	3
Connecticut	0	Deleware	2
Florida	7	Georgia	4
Hawaii	2	Idaho	1
Illinois	2	Indiana	2
Iowa	0	Kansas	0
Kentucky	0	Louisiana	3
Maine	1	Maryland	1
Massachusetts	8	Michigan	4
Minnesota	1	Mississippi	8
Missouri	1	Montana	0
Nebraska	2	New Hampshire	4
New Jersey	0	Nevada	3
New Mexico	7	New York	1
North Carolina	1	North Dakota	0
Ohio	6	Oklahoma	2
Oregon	0	Pennsylvania	1
Rhode Island	0	South Carolina	0
South Dakota	1	Tennessee	0
Texas	10	Utah	2
Vermont	0	Virginia	0
Washingto D. C.	0	Washington	1
Wisconsin	0	West Virginia	0
Overseas	6		

TABLE XV

Grade or Rank of Respondents in Sample Population

Question 3. What is your Grade or Rank?

Percentage of Responses	Grade	Percentage of Responses	Rank
4	GS 6 or lower	17	2LT or lower
8	GS 7 or 8	18	1LT
14	GS 9 or 10	5	Captain
30	GS 11 or 12	1	Major
2	GS 13 or higher	0	Lt Col. or higher
		1	Non responsive

TABLE XIV

Types of Factors (all values are percentages)

Factor	Average of Those Using the Factor	Range	Median
Hazardous work	2.22	0 - 25	2
Shift work	1.30	0 - 20	2
Overtime	2.40	0 - 30	3
Work located inside an A/C alert area	1.87	0 - 15	4
Work located on the runway	3.28	0 - 50	4
Work located on the ramp area	1.74	0 - 20	3
Work located inside a weapon storage area	2.57	0 - 50	3
Skill of workers available for the job	.95	0 - 7	2
Competition amoung bidders	1.56	0 - 35	3
Weather during the construction period	1.11	0 - 25	1
Remote site location	2.40	0 - 80	3
Accuracy of bidding documents	2.05	0 - 17	2

runway. The percentage increase for work located on the runway was 3.19, the highest average increase of all the factors surveyed.

Research Question #2. What cost percentage increase or decrease do the factors have on Air force project costs? Table XIV lists the factors and the percentage increase for each factor. The percentages for each factor are used to increase the total cost for a project. For example, the total cost for a project is $400,000 and the project is located inside a weapon storage area. Using the factor for a weapon storage area and multipling it by the cost for the project gives an additive cost to the project of $10280. Other factors could be applied to the base price of $400,000 in the same manner until all costs are included in the project.

The range indicates the low and the high values for each item. A comparison of the average values to the range indicates several respondents used very low values or did not use the factor at all. The data in Appendix B indicates for question 15 one person responded with a

25 percent increase while 80 people responded with a 2 percent or less increase. The median value for each factor is also shown in table XIV. The median value represents the middle value of all responses. For example, if 11 responsed to the question the values would be arranged in sequence and value at location 6 would be the median value.

Research Objective Two

Research objective two was to determine how estimates are currently developed at base level. To meet this objective four research questions were formulated.

Research Question #3. What estimating data bases are currently being used at base level? The Building Construction Cost Data book published by R. S. Means Company, Inc. is the one data base the majority of the estimators use. The survey indicated 88 percent use the Means data base. Only one percent of the estimators surveyed use the Richardson General Construction Estimating Standards, four percent use their own cost files, another four percent use other estimating standards, and three percent did not answer the question. Those using other data bases indicated the MCP Pricing Guide, Engineering Performance Standards, experience, McMaster Carr, past completed projects, calling suppliers downtown, newspapers, and several specific manufacturing catalogs were the major source for prices.

Research Question #4. What is the accuracy of the estimating systems currently in use? The accuracy of the estimating method used is based on a comparison of estimated costs and bid price. The questionaire divided projects into three categories: less than $200,000, $200,000 to $500,000, and greater than $500,000. Based on projects less than $200,000 the estimate, as compared to bid price, varied from plus/minus 5% to

plus/minus 15%. On projects estimated between $200,000 to $500,000 the majority of those who had projects in this category indicated a range from plus/minus 5% to plus/minus 15%. On projects over $500,000 the majority of those who had projects in this category indicated a range of plus/minus 5% to plus/minus 10%. All results from all respondents are shown in table XVII.

The accuracy of each data base was also calculated. The results of each data base as compared to the three categories are shown in several tables. The R. S. Means data is shown in table XVIII. The Richardson data is shown in table XIV. The use of the respondents own coat data is shown in table XX. The use of other data is shown in table XXI. The Lee Saylor, Engelsman, Dodge Manual and Berger Cost Files were not used by the respondents, therefore, no data could be generated for these cost books.

Research Question #5. What are the current procedures that estimators use to develop cost estimates? Since 88 percent of the respondents use the R. S. Means cost book the estimating procedure can be assumed to be a detailed quantity take-off method. The R. S. Means book is a very detailed type estimating manual and to use the manual to price quantities the quantity take-off method must be used.

Research Question #6. How much time is being spent developing cost estimates? Based upon the same categories used to determine accuracy, the time to complete the cost estimates were also calculated. The results are shown in table XXII. The questionaire surveyed projects completed within the past year. Based on the interviews a typical design schedule for one year includes 2 complex designs, 4 standard designs, 2 repetitive designs and 1 Architect/Engineer design. If the estimator completed several complex projects as opposed to standard design projects over

TABLE XVII

Accuracy of Cost Estimates

Percentage of Responses	Accuracy in Relation to Bid Price
Projects Less Than $200,000	
25	I have no projects in this category
4	Plus/minus 1% of the bid price
4	Plus/minus 2% of the bid price
1	Plus/minus 3% of the bid price
4	Plus/minus 4% of the bid price
12	Plus/minus 5% of the bid price
21	Plus/minus 10% of the bid price
12	Plus/minus 15% of the bid price
9	Plus/minus 20% of the bid price
0	Plus/minus 25% of the bid price
3	Greater than plus/minus 25% of the bid price
5	Non responsive
Projects Greater Than $200,000 and Less Than $500,000	
50	I have no projects in this category
0	Plus/minus 1% of the bid price
1	Plus/minus 2% of the bid price
2	Plus/minus 3% of the bid price
1	Plus/minus 4% of the bid price
8	Plus/minus 5% of the bid price
21	Plus/minus 10% of the bid price
9	Plus/minus 15% of the bid price
2	Plus/minus 20% of the bid price
1	Plus/minus 25% of the bid price
1	Greater than plus/minus 25% of the bid price
4	Non responsive
Projects Greater Than $500,000	
61	I have no projects in this category
0	Plus/minus 1% of the bid price
1	Plus/minus 2% of the bid price
1	Plus/minus 3% of the bid price
1	Plus/minus 4% of the bid price
10	Plus/minus 5% of the bid price
12	Plus/minus 10% of the bid price
8	Plus/minus 15% of the bid price
0	Plus/minus 20% of the bid price
1	Plus/minus 25% of the bid price
1	Greater than plus/minus 25% of the bid price
4	Non responsive

TABLE XVIII

Accuracy of R. S. Means Data (Sample size = 99)

Number of Responses	Accuracy in Relation to Bid Price
Projects Less Than $200,000	
22	I have no projects in this category
3	Plus/minus 1% of the bid price
3	Plus/minus 2% of the bid price
1	Plus/minus 3% of the bid price
4	Plus/minus 4% of the bid price
13	Plus/minus 5% of the bid price
24	Plus/minus 10% of the bid price
14	Plus/minus 15% of the bid price
6	Plus/minus 20% of the bid price
0	Plus/minus 25% of the bid price
3	Greater than plus/minus 25% of the bid price
7	Non responsive
Projects Greater Than $200,000 and Less Than $500,000	
48	I have no projects in this category
0	Plus/minus 1% of the bid price
1	Plus/minus 2% of the bid price
2	Plus/minus 3% of the bid price
0	Plus/minus 4% of the bid price
9	Plus/minus 5% of the bid price
22	Plus/minus 10% of the bid price
10	Plus/minus 15% of the bid price
1	Plus/minus 20% of the bid price
0	Plus/minus 25% of the bid price
1	Greater than plus/minus 25% of the bid price
5	Non responsive
Projects Greater Than $500,000	
59	I have no projects in this category
0	Plus/minus 1% of the bid price
1	Plus/minus 2% of the bid price
1	Plus/minus 3% of the bid price
0	Plus/minus 4% of the bid price
11	Plus/minus 5% of the bid price
13	Plus/minus 10% of the bid price
8	Plus/minus 15% of the bid price
0	Plus/minus 20% of the bid price
0	Plus/minus 25% of the bid price
1	Greater than plus/minus 25% of the bid price
5	Non responsive

TABLE XIV

Accuracy of Richardsons Data (Sample size = 1)

Number of Responses	Accuracy in Relation to Bid Price
Projects Less Than $200,000	
0	I have no projects in this category
0	Plus/minus 1% of the bid price
0	Plus/minus 2% of the bid price
0	Plus/minus 3% of the bid price
0	Plus/minus 4% of the bid price
0	Plus/minus 5% of the bid price
0	Plus/minus 10% of the bid price
0	Plus/minus 15% of the bid price
1	Plus/minus 20% of the bid price
0	Plus/minus 25% of the bid price
0	Greater than plus/minus 25% of the bid price
0	Non responsive
Projects Greater Than $200,000 and Less Than $500,000	
0	I have no projects in this category
0	Plus/minus 1% of the bid price
0	Plus/minus 2% of the bid price
0	Plus/minus 3% of the bid price
0	Plus/minus 4% of the bid price
0	Plus/minus 5% of the bid price
0	Plus/minus 10% of the bid price
0	Plus/minus 15% of the bid price
0	Plus/minus 20% of the bid price
1	Plus/minus 25% of the bid price
0	Greater than plus/minus 25% of the bid price
0	Non responsive
Projects Greater Than $500,000	
0	I have no projects in this category
0	Plus/minus 1% of the bid price
0	Plus/minus 2% of the bid price
0	Plus/minus 3% of the bid price
0	Plus/minus 4% of the bid price
0	Plus/minus 5% of the bid price
0	Plus/minus 10% of the bid price
0	Plus/minus 15% of the bid price
0	Plus/minus 20% of the bid price
1	Plus/minus 25% of the bid price
0	Greater than plus/minus 25% of the bid price
0	Non responsive

TABLE XX

Accuracy of Respondents Own Cost Data (Sample size = 4)

Number of Responses	Accuracy in Relation to Bid Price
Projects Less Than $200,000	
1	I have no projects in this category
0	Plus/minus 1% of the bid price
1	Plus/minus 2% of the bid price
0	Plus/minus 3% of the bid price
0	Plus/minus 4% of the bid price
0	Plus/minus 5% of the bid price
0	Plus/minus 10% of the bid price
0	Plus/minus 15% of the bid price
2	Plus/minus 20% of the bid price
0	Plus/minus 25% of the bid price
0	Greater than plus/minus 25% of the bid price
0	Non responsive
Projects Greater Than $200,000 and Less Than $500,000	
1	I have no projects in this category
0	Plus/minus 1% of the bid price
0	Plus/minus 2% of the bid price
0	Plus/minus 3% of the bid price
1	Plus/minus 4% of the bid price
0	Plus/minus 5% of the bid price
1	Plus/minus 10% of the bid price
0	Plus/minus 15% of the bid price
1	Plus/minus 20% of the bid price
0	Plus/minus 25% of the bid price
0	Greater than plus/minus 25% of the bid price
0	Non responsive
Projects Greater Than $500,000	
2	I have no projects in this category
0	Plus/minus 1% of the bid price
0	Plus/minus 2% of the bid price
0	Plus/minus 3% of the bid price
1	Plus/minus 4% of the bid price
0	Plus/minus 5% of the bid price
0	Plus/minus 10% of the bid price
1	Plus/minus 15% of the bid price
0	Plus/minus 20% of the bid price
0	Plus/minus 25% of the bid price
0	Greater than plus/minus 25% of the bid price
0	Non responsive

TABLE XXI

Accuracy of Other Data (Sample size = 5)

Number of Responses	Accuracy in Relation to Bid Price
Projects Less Than $200,000	
3	I have no projects in this category
1	Plus/minus 1% of the bid price
0	Plus/minus 2% of the bid price
0	Plus/minus 3% of the bid price
0	Plus/minus 4% of the bid price
0	Plus/minus 5% of the bid price
0	Plus/minus 10% of the bid price
0	Plus/minus 15% of the bid price
1	Plus/minus 20% of the bid price
0	Plus/minus 25% of the bid price
0	Greater than plus/minus 25% of the bid price
0	Non responsive
Projects Greater Than $200,000 and Less Than $500,000	
5	I have no projects in this category
0	Plus/minus 1% of the bid price
0	Plus/minus 2% of the bid price
0	Plus/minus 3% of the bid price
0	Plus/minus 4% of the bid price
0	Plus/minus 5% of the bid price
0	Plus/minus 10% of the bid price
0	Plus/minus 15% of the bid price
0	Plus/minus 20% of the bid price
0	Plus/minus 25% of the bid price
0	Greater than plus/minus 25% of the bid price
0	Non responsive
Projects Greater Than $500,000	
5	I have no projects in this category
0	Plus/minus 1% of the bid price
0	Plus/minus 2% of the bid price
0	Plus/minus 3% of the bid price
0	Plus/minus 4% of the bid price
0	Plus/minus 5% of the bid price
0	Plus/minus 10% of the bid price
0	Plus/minus 15% of the bid price
0	Plus/minus 20% of the bid price
0	Plus/minus 25% of the bid price
0	Greater than plus/minus 25% of the bid price
0	Non responsive

TABLE XXII

Time to Complete Estimates

Percentage of Responses	Time to Complete an Estimate
Projects Less Than $200,000	
16	I have no projects in this category
26	Less than 8 hours (1 day)
37	1 to 2 days
10	3 to 4 days
4	5 to 6 days
1	7 to 8 days
1	9 to 10 days
3	Over 10 days
2	Non responsive
Projects Greater Than $200,000 and Less Than $500,000	
44	I have no projects in this category
4	Less than 8 hours (1 day)
22	1 to 2 days
9	3 to 4 days
7	5 to 6 days
4	7 to 8 days
1	9 to 10 days
3	Over 10 days
6	Non responsive
Projects Greater Than $500,000 and Less Than $1,000,000	
60	I have no projects in this category
3	Less than 8 hours (1 day)
8	1 to 2 days
11	3 to 4 days
2	5 to 6 days
3	7 to 8 days
2	9 to 10 days
6	Over 10 days
5	Non responsive
Projects Greater Than $1,000,000	
69	I have no projects in this category
2	Less than 8 hours (1 day)
3	1 to 2 days
6	3 to 4 days
5	5 to 6 days
2	7 to 8 days
1	9 to 10 days
7	Over 10 days
5	Non responsive

TABLE XXIII

Data Base Content

Title	Responses	Ranking
Description	241	1
Material cost (without any mark-up)	353	2
Labor cost (without any mark-up)	408	3
Unit of measure	415	4
Equipment costs (without any mark-up)	552	5
Total cost (without any mark-up)	627	6
Man-hours to complete the work item	680	7
Material cost (including mark-up)	722	8
Crew	750	9
Labor cost (including mark-up)	760	10
Sub-contract item	848	11
Total cost (including mark-up)	849	12
Equipment cost (including mark-up)	871	13

the past year the average time to complete an estimate would be longer. The responses indicate an average time to complete a cost estimate based on several types of projects an estimator may receive over a one year time period.

Research Objective Three

Research objective three was to develop criteria to measure estimating system quality. To meet this objective two research questions were formulated.

Research Question #7. What major items need to be included as part of the data base to develop an accurate estimate? The questionaire was used to determine what items should be included in the data base. Based on the results shown in table XXIII all items could be used for computing the total cost of a project. Other items could be added to the data base at the discretion of the estimator.

Research Question #8. What major factors affect estimating system

usability? Based on the literature review of existing estimating systems several items appear to cause a system to fail. These items included an extensive data base that was hard to update costs and the use of hidden factors that were applied to costs and not explained for the estimator. Refer to table X in Chapter 2 for a list of major disadvantages for various estimating systems.

The proposed system will keep the data base simple for easy updates or modifications and the additional factors will be explained in the estimating program through the use of computer prompts. The estimator then has a choice of using the factors, deleting the factors, or changing the values. The proposed system is designed for an inexperienced operator to use. The computer prompts for inputs and will display several options to the estimator. The data base is provided by the estimator so the estimator knows exactly what items are included in the costs and the format for each item is the same throughout the data base. Even if a mistake is found in the data base the estimator can easily change the cost for any item. Table XXIV shows the proposed system compared to the disadvantages of existing systems.

Research Objective Four

Research objective four was to develop an improved estimating system. In order to meet objective four two research questions were formulated. The items included in the estimating system were based on the literature review and the factors listed on the questionaires that effect project costs at Air Force bases. The estimating system was designed to default to a standard set of values and then prompt the estimator if the standard values would be used or if the estimator wanted to input their

TABLE XXIV

Comparison of Proposed System to Existing Systems

Major Disadvantages of Existing Systems	Proposed System
modifiers not explained	modifiers explained in the program
material prices not documented	prices supplied by the user
expertise to run the system	program prompts user for inputs
lack of flexibility in formats	estimator has a choice of formats
updating extensive data base	data base is easy to modify
lack of modifiers for escalation	estimator can add modifiers
data base inconsistency	data base supplied by the user
	data base format does not change
mistakes in the data base	if a mistake is found it can easily be changed

own values for each item. The proposed system also included areas where the estimator could add additional factors.

Research Question #9. How does the proposed system implement the findings of this research? Based on the literature review of several existing cost estimating systems and the factors the systems used to prepare costs, the proposed system has incorporated several factors. The factors included in the program were: overhead for the general contractor (25%), performance bond cost in dollars per thousand ($12.00), worker's compensation (9.03%), builders risk and public liability insurance (1.2%), social security (7%), unemployment tax (3.6%), material sales tax (6%), and profit (10%). The program prompts the user if changes were needed to the overhead and profit factors.

The program included the additional factors shown in Chapter 2, table IX, as an option for the estimator to add at the end of the program. The estimator could add any factor in this section of the program by naming the factor and then assigning the factor a percentage to be taken of the

TABLE XXV

Comparison of Estimating Methods Man-hour Requirements

Project Title	Quantity Take-off Method Hours	Computerized Method Hours
Foundation	4	2
Main Gate	21	14
Electrical	24	14

total costs of the project.

Research Question #10. How does the proposed system compare with existing systems using established criteria? The comparison of the proposed system to existing systems is shown in table XXIV. In addition, three case studies were used to validate the estimating procedure. The projects consisted of a new main gate entrance, a foundation project and the electrical portion of a large facility. In each case the Government estimate and the low bid estimate are compared to the computerized estimating procedure costs. Each case is evaluated on time to complete the estimate and accuracy of the estimate as compared to the low responsive and responsible bid.

In all three case studies the time to complete the estimates is reduced substantially using the computerized estimating procedure. Table XXV shows a comparison of the man-hours it takes to complete an estimate on each case study using the computerized procedure and the usual quantity take-off method.

The accuracy of the estimating procedure is compared to each case study by using the government estimate and the responsive and responsible bid cost. Table XXVI shows the results of the computerized procedure as compared to the Government estimate and low bid. The low bid for the

TABLE XXVI

Comparison of Estimating Methods Based on Accuracy

Project Title	Government Estimate	Low Bid	Computerized Estimate
Foundation	$24,833.00	N/A	$24,525.00
Main Gate	$78,325.00	$76,667.00	$75,893.00
Electrical	$102,480.00	$81,000.00	$97,634.00

foundation project is not available since this project has not been advertised for bids.

V. Conclusions

Research Objective One.

The first objective of this research was to analyze the Air Force Civil Engineering design system and determine what factors effect the costs of construction on Air Force Bases. To accomplish the first objective two research questions were developed: What estimating factors influence the costs of Air Force projects? What percentage increase or decrease do the factors have on Air Force projects?

Based on the literature review of existing cost estimating methods several factors need to be addressed. These factors are shown in Chapter 2, table VIII, with the percentage increase for a particular project. But these factors are not enough for Air Force projects. Other factors peculiar only to Air Force projects must be considered. These Air Force factors were presented in Chapter 4, table XIV. By using the existing factors along with the Air Force factors a more accurate construction cost estimate may result.

Research Objective Two.

The second objective of this research was to determine how estimates were currently developed at base level. To accomplish this objective four research questions were developed: What estimating data base was currently being used at base level? What was the accuracy of the estimating system currently being used? What were the current procedures the estimator used to develop a cost estimate? How much time was being spent developing cost estimates?

The R. S. Means "Building Construction Cost Data" is the one data base the majority of bases use. Eighty-eight percent use the R. S. Means

data base. Since a large majority used only one data base the accuracy of the data when compared to bids could also be measured accurately by the survey. The accuracy of the existing data base, R. S. Means, is between plus/minus 5% and plus/minus 15% of the low bid regardless of the dollar amount of the project. Table XVIII located in Chapter 4 lists in more detail how the respondents using the R. S. Means data responded when compared to the low bid on various size projects.

The current procedure an estimator uses for final cost estimates is the detailed quantity take-off method. The estimator completes the quantity take-off and then prices each item using the R. S. Means "Building Construction Cost Data" book.

Depending on the types of projects an estimator completes during the year will effect the time it takes to complete the cost estimate. The data indicates a range of between 1 day for simple projects less than $200,000 to 4 days for complex projects around $500,000. Table XXII located in Chapter 4 lists the respondents results based on the time to complete a project estimate.

Research Objective Three.

The third research objective was to develop criteria to measure estimating system quality. To accomplish this two research questions were developed: What major items need to be included as part of the data base to develop an accurate estimate? What major factors affect estimating system usability.

The major items cost estimators need to develop an accurate estimate were shown in table XXIII in Chapter 4. All of the items could be added to the data base for any particular Air Force installation. The first

seven items include a brief description of work, material cost, labor cost, unit of measure, equipment cost, and total cost for each item found in a project. Also, the costs associated with each item does not include any mark-ups of any kind. This allows the estimator to custom fit the price to any situation by appling several factors to the original cost.

Many of the problems with existing systems were too large a data base, hard to up date costs in the data base, and hidden factors the estimators did not know a cost for. The proposed procedure developed for this research attempted to solve many of the problems listed in table XXIV in Chapter 4 for existing systems by keeping the data base simple and easy to modify. In addition, the programs prompt the user for input items and all items automatically default to a listed value by the choice of the estimator. The procedure allows the estimator to make changes, add additional factors and change the data base if the estimator decides to do so. The system is very flexible.

Research Objective Four.

The fourth objective of this research was to develop an improved estimating system. To accomplish this objective two research questions were developed: How does the proposed system implement the findings of this research? How does the proposed system compare with existing systems using established criteria?

The findings of this research indicated a list of factors that were added to the proposed system. The factors have a small range of values according to the literature that was researched. The factors were added to the procedure and standard default values were given to each factor. The estimator has a choice of using the default value or another value that may be more accurate

for the project.

The additional Air Force factors were also included in the program by the use of a prompt. The estimator can then add the additional factor and the percent to increase or decrease the cost. The estimator can delete or change the values at a later date if the additional factor isno longer needed.

One of the goals for this research was to develop a procedure to accurately estimate costs and reduce the preparation time by using several computer programs to generate a cost estimate. As shown in Chapter 4, tables XXV and XXVI, the proposed estimating system maintains the accuracy of the cost estimate but significantly reduces the preparation time. The accuracy of the proposed system may be questioned because of the data base used. The data base the author used was based on two cost estimating books published by R. S. Means, the "1984 Building Construction Cost Data" and "1985 Building Construction Cost Data". The data was used mainly to test the procedure and not the accuracy of the data base. The actual data base used by the estimators at base level would vary from location to location and represent true costs for that location. The data the author used represented average costs for each item of work. The proposed system cost was still very close to the government estimate and low bid.

In conclusion, if an estimator at base level would input their own costs for use in the data base and apply the estimating procedure described in the user manual in Appendix C an accurate total cost for a project could be generated with less preparation time. Also, the procedure for the final estimate could be standardized and if an estimator moved locations the data would be different and the factors would change but the basic procedure would still lead the estimator to an accurate final cost estimate.

The programs for developing a computer cost estimating procedure are

located in the user manual in Appendix C. The user manual explains in detail how to run the estimating procedure.

Further research needs to be conducted to actually test the new estimating procedure on various projects. In order to accomplish this a local data base also needs to be developed. Once the estimator has become familiar with the system and how to operate the estimating programs several projects could be tested for accuracy and the time to complete the estimate.

APPENDIX A: QUESTIONAIRE

1. How many years of estimating experience do you have?
   - O less than 1 year
   - O over 1 year but less than 2 years
   - O over 2 years but less than 3 year
   - O over 3 years but less than 4 years
   - O over 4 years but less than 5 years
   - O over 5 years

2. What State is your base located in?

3. What is your grade or rank?

O GS 6 or lower	O 2LT or lower
O GS 7 or 8	O 1LT
O GS 9 or 10	O Capt
O GS 11 or 12	O Major
O GS 13 or higher	O Lt Col or higher

4. What estimating data base are you currently using?
   - O R. S. Means
   - O Lee Saylor
   - O Engelsman
   - O Dodge Manual
   - O Richardson
   - O Berger Cost Files
   - O I use my own cost data file
   - O Other (please specify _____)

5. Based on the projects less than $200,000 completed in the past year what is the accuracy of the data you used?
   - O I have no projects in this category
   - O plus/minus 1% of the bid price
   - O plus/minus 2% of the bid price
   - O plus/minus 3% of the bid price
   - O plus/minus 4% of the bid price
   - O plus/minus 5% of the bid price
   - O plus/minus 10% of the bid price
   - O plus/minus 15% of the bid price
   - O plus/minus 20% of the bid price
   - O plus/minus 25% of the bid price
   - O greater then plus/minus 25% of the bid price

6. Based on the projects over $200,000 but less then $500,000 completed in the past year what is the accuracy of the data you used?
   - O I have no projects in this category
   - O plus/minus 1% of the bid price
   - O plus/minus 2% of the bid price
   - O plus/minus 3% of the bid price
   - O plus/minus 4% of the bid price
   - O plus/minus 5% of the bid price
   - O plus/minus 10% of the bid price
   - O plus/minus 15% of the bid price
   - O plus/minus 20% of the bid price
   - O plus/minus 25% of the bid price
   - O greater then plus/minus 25% of the bid price

7. Based on the projects over $500,000 completed in the past year what is the accuracy of the data you used?
   - O I have no projects in this category
   - O plus/minus 1% of the bid price
   - O plus/minus 2% of the bid price
   - O plus/minus 3% of the bid price
   - O plus/minus 4% of the bid price
   - O plus/minus 5% of the bid price
   - O plus/minus 10% of the bid price
   - O plus/minus 15% of the bid price
   - O plus/minus 20% of the bid price
   - O plus/minus 25% of the bid price
   - O greater then plus/minus 25% of the bid price

8. On projects less than $200,000 what is the amount of time you spend preparing the cost estimate?
   - O I have no projects in this category
   - O less than 8 hrs (1 day)
   - O 1 to 2 days
   - O 3 to 4 days
   - O 5 to 6 days
   - O 7 to 8 days
   - O 9 to 10 days
   - O over 10 days

9. On projects more than $200,000 but less than $500,000 what is the amount of time you spend preparing the cost estimate?
   - O I have no projects in this category
   - O less than 8 hrs (1 day)
   - O 1 to 2 days
   - O 3 to 4 days
   - O 5 to 6 days
   - O 7 to 8 days
   - O 9 to 10 days
   - O over 10 days

10. On projects more than $500,000 but less than $1,000,000 what is the amount of time you spend preparing the cost estimate?
    - O I have no projects in this category
    - O less than 8 hrs (1 day)
    - O 1 to 2 days
    - O 3 to 4 days
    - O 5 to 6 days
    - O 7 to 8 days
    - O 9 to 10 days
    - O over 10 days

11. On projects more than $1,000,000 what is the amount of time you spend preparing the cost estimate?
    - O I have no projects in this category
    - O less than 8 hrs (1 day)
    - O 1 to 2 days
    - O 3 to 4 days
    - O 5 to 6 days
    - O 7 to 8 days
    - O 9 to 10 days
    - O over 10 days

12. Does your existing data base explain in detail how the costs were derived?
    - O yes
    - O no

13. If you had to explain a cost for a work item in detail does your existing data base explain what factors to use?
    - O yes
    - O no

14. If answered yes to the above question, does your data base give an approximate percentage of costs to use for the factors?
    - O yes
    - O no

For the following factors indicate a low, a high, and an average value you would use on a typical construction project at your base. These factors would be applied as a percentage of the total construction costs.

Factor	Low	High	Average
EX. Skilled workers available for the job	-3	+4	+1
15. Hazardous work	____	____	____
16. Shift work	____	____	____
17. Overtime	____	____	____
18. Work located inside an aircraft alert area	____	____	____
19. Work located on the runway	____	____	____
20. Work located on the ramp area	____	____	____
21. Work located inside weapon storage areas	____	____	____
22. Skill of workers available for the project	____	____	____
23. Competition amoung bidders	____	____	____
24. Weather during the construction period	____	____	____
25. Remote site location	____	____	____
26. Accuracy of bidding documents	____	____	____

Please list any additional factors along with the values used

_____	____	____	____
_____	____	____	____
_____	____	____	____
_____	____	____	____

The following list contains items that many cost estimating books use in their description of a work item. Please rank each item in order of importance (1 being the most important and so on).

	Ranking	Title
27.	____	Description
28.	____	Crew
29.	____	Unit of measure
30.	____	Sub-contract item
31.	____	Material cost (without any mark-up)
32.	____	Labor cost (without any mark-up)
33.	____	Equipment cost (without any mark-up)
34.	____	Total cost (without any mark-up)
35.	____	Man-hours to complete the work item
36.	____	Material cost (with mark-up included)
37.	____	Labor cost (with mark-up included)
38.	____	Equipment cost (with mark-up included)
39.	____	Total cost (with mark-up included)

List any other items you may want to add to the above and show the ranking where it would fall in relation to the above rankings you just completed.

EX. Trade class 1A means the trade class would be ranked first after item 1 from the above list.

_____ ____

_____ ____

_____ ____

APPENDIX B: DATA BASE

REPORT DATE 06/03/86

SURVEY2 DATA. THIS DATA REPRESENTS THE NUMERICAL DATA USED IN THE SURVEY2 PROGRAM BASED ON THE CONSTRUCTION COST ESTIMATING QUESTIONAIRES

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06/03/86 SU VEY2 DATA.

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06/03/86 SURVEY2 DATA.

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APPENDIX C: USER MANUAL FOR ESTIMATING PROCEDURE

TABLE OF CONTENTS

INTRODUCTION

The manual explains how to use several computer programs and how to develop the necessary controls, data, and report procedures necessary to produce a final construction cost estimate. All the computer programs for the estimating procedure are included in this manual. The programs are written in BASIC computer language and the procedure is compatible with the WANG VS100 computer system. This manual assumes the user has a basic knowledge of the WANG VS100 operating system.

The manual is divided into three sections: Section I explains how to set up procedures to manipulate the main data file, Section II explains how to set up procedures to manipulate the project data files created as a result of running the ESTIMATE program, and Section III explains the computer programs used for the estimating procedure. Included in the Appendix are all the programs necessary to develop a construction cost estimate.

When all programs and procedures are entered into the computer system the estimator is ready to begin. A diagram showing the basic steps required to generate a cost estimate using this manual is shown in figure 1 of this manual.

Run ESTIMATE
Program
(This program produces the two
files shown below. Additions to
the files are made by running the
ESTIMATE program.)

Description File	Quantity File
Run INDEXDES Program	Run INDEXQNT Program

Additions, Deletions, and Modifications can now be made directly to the project files using the procedures described in this manaul without running the ESTIMATE program.

Run SORT Procedure	Run SORT Procedure
Run DESCRIPT Program (Report oriented format)	Run QUANTITY Program (Report oriented format)

Fig 1. Steps Required to Produce a Cost Estimate

Section I: MAIN DATA FILE

Main Data File

The main data file is where all the data used in the ESTIMATE program is stored. The user is responsible for inputing all the data into this file and updating costs. The following procedures explain how to set up a control file, enter data, modify data, delete data, create a report definition, and run a report on the main data file.

Developing the Main Data Base. The following steps are used to develop several procedures needed before the ESTIMATE program can run correctly.

Data Base Control Set-Up:

1. Logon to the system using standard procedures.

2. The logon menu indicating the PF key for the Utility Menu is now on the monitor. Press the PF key opposite Utility Menu, in this example it's PF key 7 (figure 2).

3. The main Utility Menu is now on the monitor. In order to create a data base file a control file must first be created to define how the data will be stored in the file. Press the PF key opposite Control, in this example it's PF key 1 (figure 3).

4. The next screen (figure 4) prompts for the name of the control file. Type in ESTIMATE as shown in figure 5 and press "enter".

5. The next screen is the Control File Menu (figure 6). To create a control file press PF key 2.

6. The next screen now indicates creation of file header information (figure 7). Type in the items shown in figure 8 and press "enter".

7. The creation of field specifications is now on the

monitor (figure 9). Each field in the data base must have a specification. A total of eleven fields are used in the data base. Type in the items shown in Figures 10 thru 20 for each field. After completing a specification press "enter". In some cases the screen showing Field Input Validation Specifications may appear (figure 21). Do nothing to this screen, press "enter" and the field specification screen will reappear.

8. After entering the last field press PF key 16 to return to the Control File Menu. A control file now exists called ESTIMATE. Continue pressing PF key 16 until the main Utility Menu is reached.

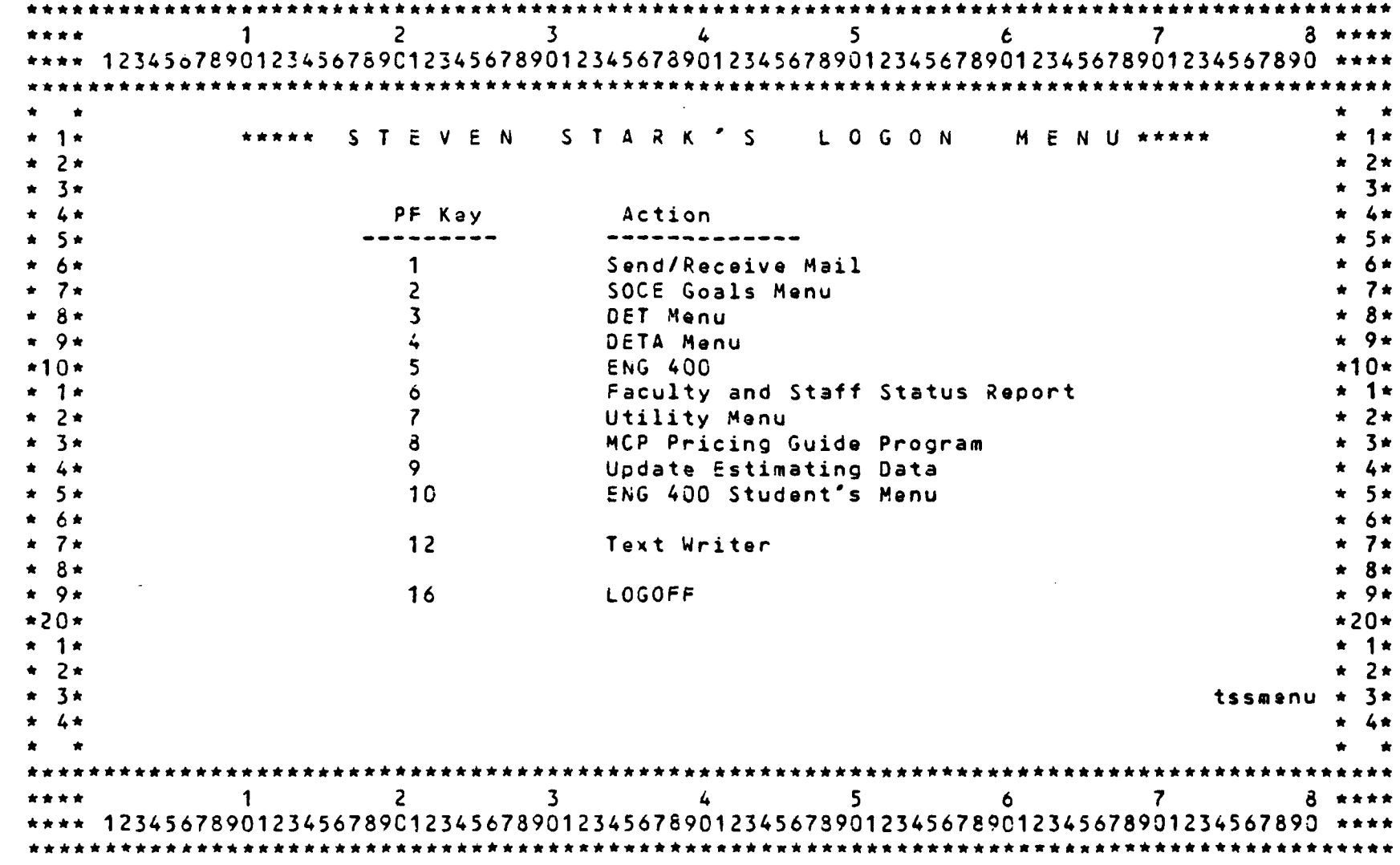


Fig 2. Logon Menu

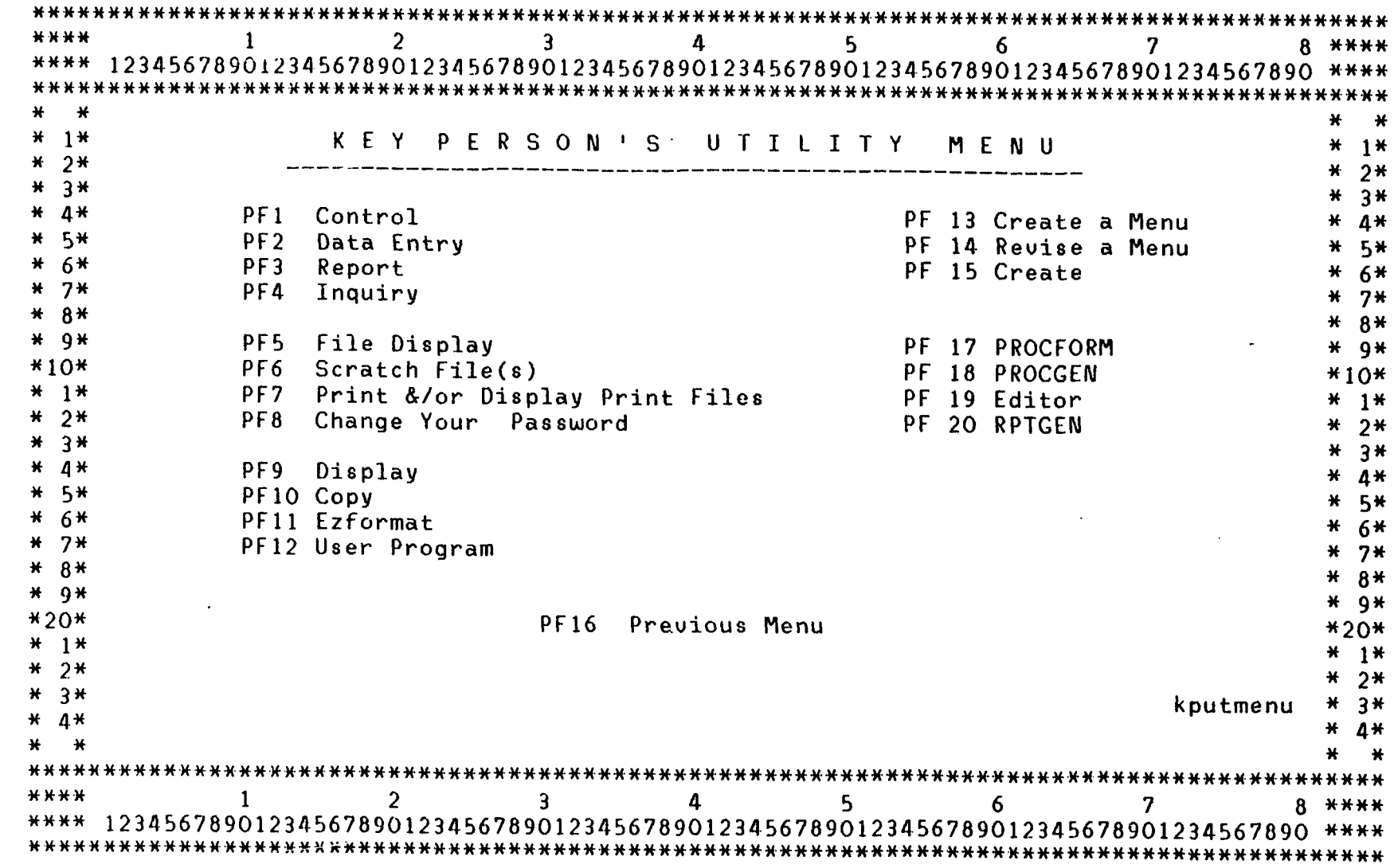


Fig 3. Utility Menu

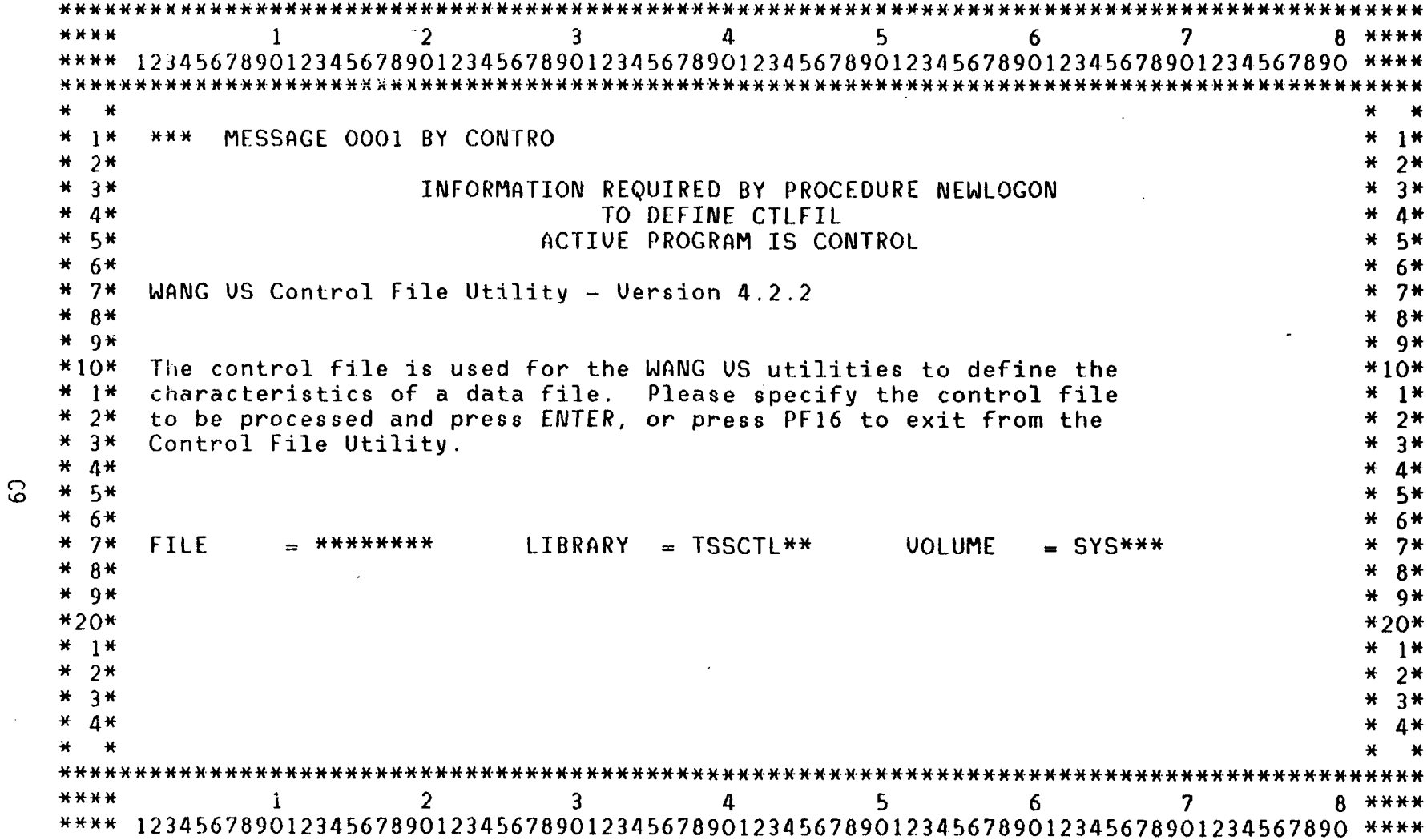


Fig 4. Control File Utility

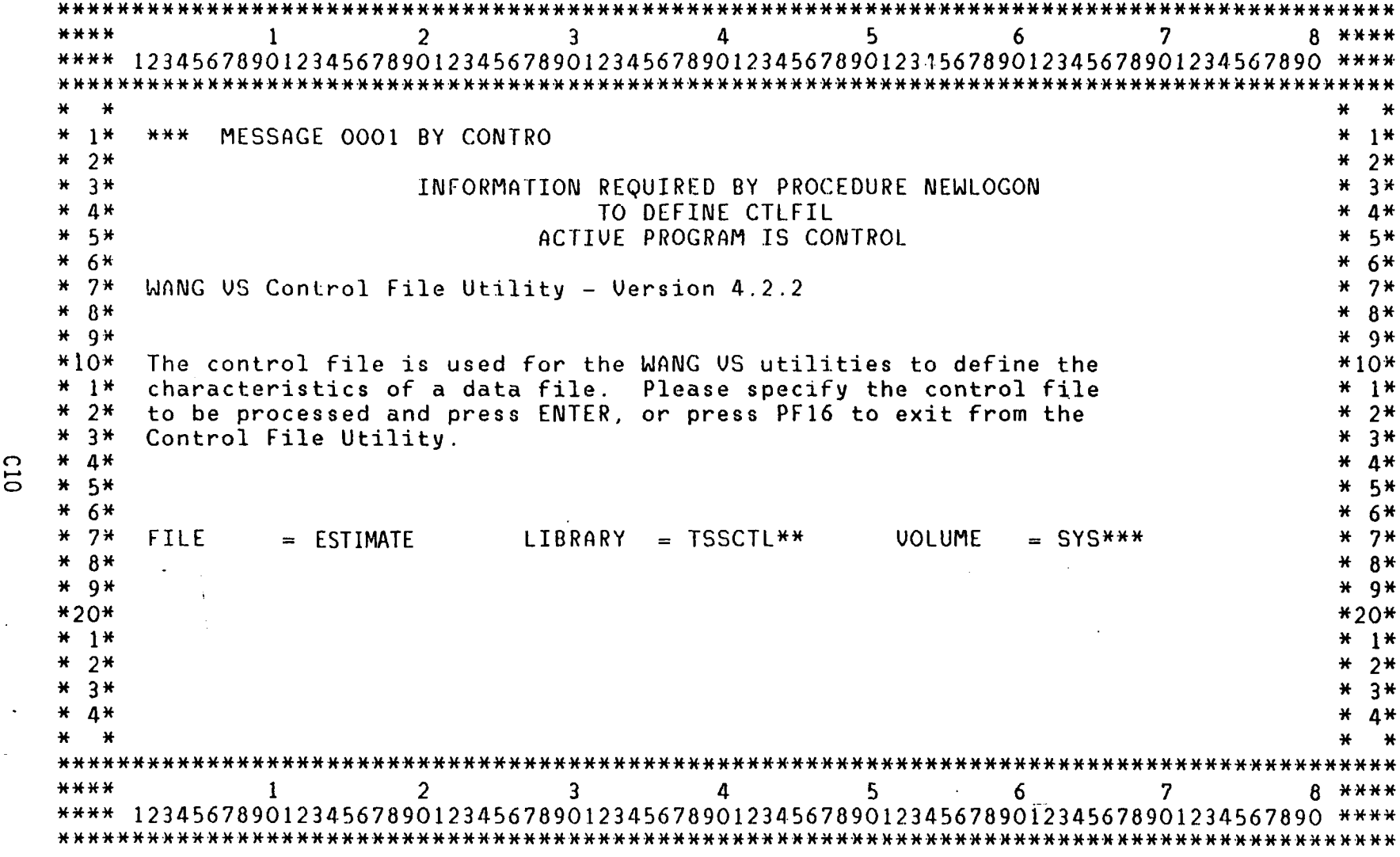


Fig 5. Control File Utility

```
**********************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
**********************************************************************************
*  *                                                                             *  *
* 1*  ***  MESSAGE 0002 BY CNTRL                                                 * 1*
* 2*                                                                             * 2*
* 3*                    INFORMATION REQUIRED BY PROCEDURE NEWLOGON                * 3*
* 4*                                  TO DEFINE OPTIONS                         * 4*
* 5*                             ACTIVE PROGRAM IS CONTROL                      * 5*
* 6*                                                                             * 6*
* 7*  Press the appropriate pfkey for control file option                       * 7*
* 8*                                                                             * 8*
* 9*                     PFKEY            ACTION                                * 9*
*10*                       2          create a control file                     *10*
* 1*                       3          add records to a control file             * 1*
* 2*                       4          modify control file header or field records * 2*
* 3*                       5          delete records from a control file        * 3*
* 4*                       6          list records on a control file            * 4*
* 5*                       7          maintain table entries                    * 5*
* 6*                       8          create source from this control file      * 6*
* 7*                       9          run WANG VS Data Entry Utility            * 7*
* 8*                      10          run WANG VS Report Utility                * 8*
* 9*                      11          run WANG VS Screen Formatting Utility     * 9*
*20*                      12          modify field update sequence              *20*
* 1*                                                                             * 1*
* 2*                      16          exit to respecify control file location   * 2*
* 3*                                                                             * 3*
* 4*                                                                             * 4*
*  *                                                                             *  *
**********************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
**********************************************************************************
```

Fig 6. Control File Menu

```
**********************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
**********************************************************************************
*  *                                                                             *  *
* 1*  ***  MESSAGE C001 BY CONTRO                                               * 1*
* 2*                                                                             * 2*
* 3*                    INFORMATION REQUIRED BY PROCEDURE NEWLOGON                * 3*
* 4*                                 TO DEFINE HEADER                           * 4*
* 5*                              ACTIVE PROGRAM IS CONTROL                     * 5*
* 6*                                                                             * 6*
* 7*  Creation of file header information.  Enter parameters for the data file.   * 7*
* 8*                                                                             * 8*
* 9*                                                                             * 9*
*10*  RECLEN    = ****          (1-2040 fixed; 1-2020 var; 1-2024 compress length)  *10*
* 1*  KEYFIELD = ********      (assume consecutive file if not specified)          * 1*
* 2*  ALTKEYS  = 00            (1-16,number of alternate keys to indexed file)     * 2*
* 3*  USEREXIT = ********      (user supplied, if any: "USER1" -- "USER10")        * 3*
* 4*  REPORT   = 0             (0-report allowed, 1-not allowed)                   * 4*
* 5*  UPDATE   = 0             (0-record update allowed, 1-not allowed)            * 5*
* 6*  DELETE   = 0             (0-record deletions allowed, 1-not allowed)         * 6*
* 7*  FILETYPE = F             (F-fixed, V-variable, C-compressed records)         * 7*
* 8*  COMMENT1 = ************************************************************      * 8*
* 9*  COMMENT2 = ************************************************************      * 9*
*20*  COMMENT3 = ************************************************************      *20*
* 1*                 ***any comments to be included in file***(optional)         * 1*
* 2*                                                                             * 2*
* 3*                 Press PF16 to return to Control File Utility menu           * 3*
* 4*                                                                             * 4*
*  *                                                                             *  *
**********************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
**********************************************************************************
```

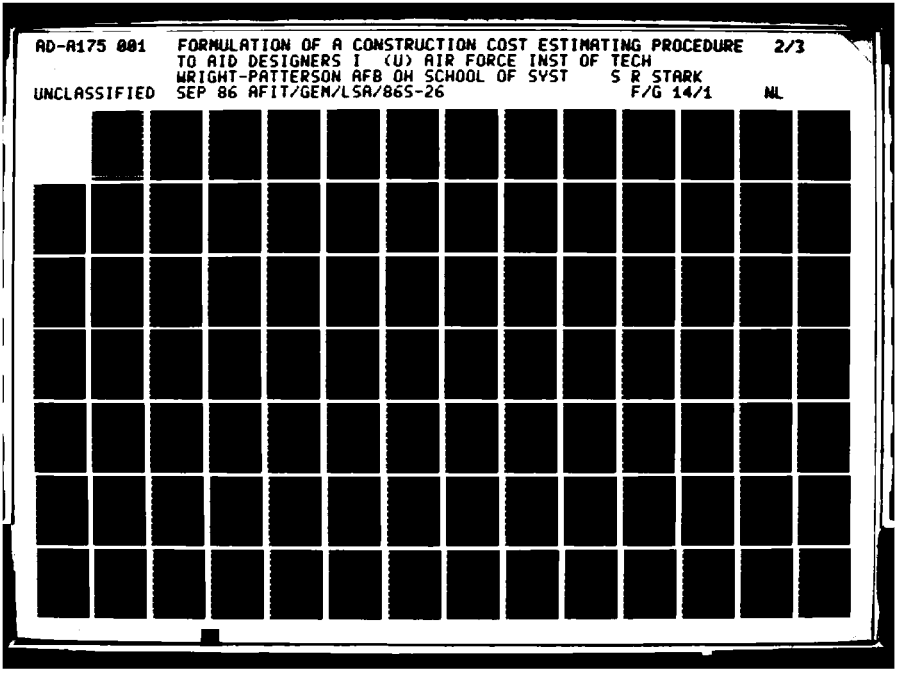
Fig 7. File Header

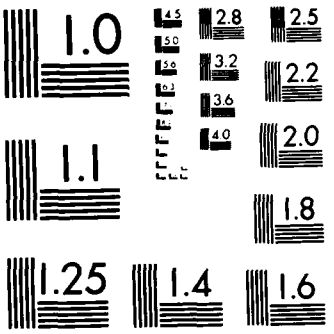
```
*****************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
*****************************************************************************
*  *                                                                        *  *
* 1*  ***  MESSAGE C001 BY CONTRO                                          * 1*
* 2*                                                                        * 2*
* 3*                      INFORMATION REQUIRED BY PROCEDURE NEWLOGON        * 3*
* 4*                                  TO DEFINE HEADER                      * 4*
* 5*                              ACTIVE PROGRAM IS CONTROL                 * 5*
* 6*                                                                        * 6*
* 7*  Creation of file header information.  Enter parameters for the data file. * 7*
* 8*                                                                        * 8*
* 9*                                                                        * 9*
*10*  RECLEN   = 150          (1-2040 fixed; 1-2020 var; 1-2024 compress length) *10*
* 1*  KEYFIELD = CODE         (assume consecutive file if not specified)     * 1*
* 2*  ALTKEYS  = 00           (1-16,number of alternate keys to indexed file) * 2*
* 3*  USEREXIT = ********     (user supplied, if any: "USER1" -- "USER10")   * 3*
* 4*  REPORT   = 0            (0-report allowed, 1-not allowed)              * 4*
* 5*  UPDATE   = 0            (0-record update allowed, 1-not allowed)       * 5*
* 6*  DELETE   = 0            (0-record deletions allowed, 1-not allowed)    * 6*
* 7*  FILETYPE = V            (F-fixed, V-variable, C-compressed records)    * 7*
* 8*  COMMENT1 = ************************************************************ * 8*
* 9*  COMMENT2 = ************************************************************ * 9*
*20*  COMMENT3 = ************************************************************ *20*
* 1*                ***any comments to be included in file***(optional)     * 1*
* 2*                                                                        * 2*
* 3*                Press PF16 to return to Control File Utility menu       * 3*
* 4*                                                                        * 4*
*  *                                                                        *  *
*****************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
*****************************************************************************
```

Fig 8. File Header Completed

```
**********************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
**********************************************************************************
*  *                                                                             *  *
* 1*                        Creation of field specifications.                    * 1*
* 2*                                                                             * 2*
* 3*                    These entries create the field specifications            * 3*
* 4*                                  for the file.                              * 4*
* 5*                     Make the appropriate entries and press ENTER.           * 5*
* 6*                                                                             * 6*
* 7*     Field name:  ********                                                   * 7*
* 8*     Start loc:   ****                                                       * 8*
* 9*     Int. format: C          (P-packed, B-binary, C-character, Z-zoned, U-unsigned) * 9*
*10*     Int. length: ***        (# disk pos - max: P-8, B-4, C-132, Z-15, U-15)  *10*
* 1*     Ext. length: ***        (only if not calculated from int. length)       * 1*
* 2*     Decimal pos: 0          (0-9, define for numeric fields only)           * 2*
* 3*     Occurrences: 01         (number of times this field repeated)           * 3*
* 4*     Report code: 0          (0-report of field allowed, 1-not allowed)      * 4*
* 5*     Update code: 0          (0-update of field allowed, 1-not allowed)      * 5*
* 6*     Dsplay code: 0          (0-blank after, 1-no blank after, 2-display only) * 6*
* 7*     0-suppress : 0          (0-no zero suppress,1-suppress leading zero,2-* prot) * 7*
* 8*     Sign contrl: 0          (0-no sign,1-trailing minus,2-CR on -,3-DB on -) * 8*
* 9*     Dol/comma  : 0          (0-none  1-","  2-"$"  3-"$" and ",")           * 9*
*20*     Binary edit: 0          (0-hex, 1-CVB ,used only for INTERNAL FORMAT=B) *20*
* 1*     Date stamp:  0          (0-no, 1-yes)                                   * 1*
* 2*     Cum. field:  ********   (Enter field name to be accumulator)            * 2*
* 3*     Field alias: ********************************* (alternate name-used by INQUIRY) * 3*
* 4*                  Press PF16 to return to Control File Utility menu.         * 4*
*  *                                                                             *  *
**********************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
**********************************************************************************
```

Fig 9. Field Specifications


AD-A175 001
FORMULATION OF A CONSTRUCTION COST ESTIMATING PROCEDURE
TO AID DESIGNERS I (U) AIR FORCE INST OF TECH
WRIGHT-PATTERSON AFB OH SCHOOL OF SYST
S R STARK
UNCLASSIFIED
SEP 86 AFIT/GEM/LSA/86S-26
F/G 14/1
NL
2/3



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

```
**********************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
**********************************************************************************
*  *                                                                             *  *
* 1*                        Creation of field specifications.                    * 1*
* 2*                                                                             * 2*
* 3*                   These entries create the field specifications             * 3*
* 4*                                  for the file.                              * 4*
* 5*                    Make the appropriate entries and press ENTER.            * 5*
* 6*                                                                             * 6*
* 7*     Field name:  UCI                                                        * 7*
* 8*     Start loc:   001                                                        * 8*
* 9*     Int. format: P          (P-packed, B-binary, C-character, Z-zoned, U-unsigned) * 9*
*10*     Int. length: 3          (# disk pos - max: P-8, B-4, C-132, Z-15, U-15)  *10*
* 1*     Ext. length: 7          (only if not calculated from int. length)       * 1*
* 2*     Decimal pos: 0          (0-9, define for numeric fields only)           * 2*
* 3*     Occurrences: 01         (number of times this field repeated)           * 3*
* 4*     Report code: 0          (0-report of field allowed, 1-not allowed)      * 4*
* 5*     Update code: 0          (0-update of field allowed, 1-not allowed)      * 5*
* 6*     Dsplay code: 0          (0-blank after, 1-no blank after, 2-display only) * 6*
* 7*     0-suppress : 0          (0-no zero suppress,1-suppress leading zero,2-* prot) * 7*
* 8*     Sign contrl: 0          (0-no sign,1-trailing minus,2-CR on -,3-DB on -) * 8*
* 9*     Dol/comma  : 0          (0-none  1-","  2-"$"  3-"$" and ",")           * 9*
*20*     Binary edit: 0          (0-hex, 1-CUB ,used only for INTERNAL FORMAT=B) *20*
* 1*     Date stamp:  0          (0-no, 1-yes)                                   * 1*
* 2*     Cum. field:  ********   (Enter field name to be accumulator)            * 2*
* 3*     Field alias: ********************************* (alternate name-used by INQUIRY) * 3*
* 4*                  Press PF16 to return to Control File Utility menu.         * 4*
*  *                                                                             *  *
**********************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
**********************************************************************************
```

Fig 10. Field Specification for UCI

```
**********************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
**********************************************************************************
*  *                                                                             *  *
* 1*                        Creation of field specifications.                    * 1*
* 2*                                                                             * 2*
* 3*                  These entries create the field specifications              * 3*
* 4*                                  for the file.                              * 4*
* 5*                   Make the appropriate entries and press ENTER.             * 5*
* 6*                                                                             * 6*
* 7*    Field name:  CODE                                                        * 7*
* 8*    Start loc:   004                                                         * 8*
* 9*    Int. format: P          (P-packed, B-binary, C-character, Z-zoned, U-unsigned) * 9*
*10*    Int. length: 7          (# disk pos - max: P-8, B-4, C-132, Z-15, U-15)   *10*
* 1*    Ext. length: 14         (only if not calculated from int. length)        * 1*
* 2*    Decimal pos: 0          (0-9, define for numeric fields only)            * 2*
* 3*    Occurrences: 01         (number of times this field repeated)            * 3*
* 4*    Report code: 0          (0-report of field allowed, 1-not allowed)       * 4*
* 5*    Update code: 0          (0-update of field allowed, 1-not allowed)       * 5*
* 6*    Dsplay code: 0          (0-blank after, 1-no blank after, 2-display only) * 6*
* 7*    0-suppress : 0          (0-no zero suppress,1-suppress leading zero,2-* prot) * 7*
* 8*    Sign contrl: 0          (0-no sign,1-trailing minus,2-CR on -,3-DB on -) * 8*
* 9*    Dol/comma  : 0          (0-none  1-","  2-"$"  3-"$" and ",")            * 9*
*20*    Binary edit: 0          (0-hex, 1-CVB ,used only for INTERNAL FORMAT=B)   *20*
* 1*    Date stamp:  0          (0-no, 1-yes)                                    * 1*
* 2*    Cum. field:  ********   (Enter field name to be accumulator)            * 2*
* 3*    Field alias: ******************************* (alternate name-used by INQUIRY) * 3*
* 4*                 Press PF16 to return to Control File Utility menu.          * 4*
*  *                                                                             *  *
**********************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
**********************************************************************************
```

Fig 11. Field Specification for CODE

```
*****************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
*****************************************************************************
*  *                                                                          *  *
* 1*                        Creation of field specifications.                 * 1*
* 2*                                                                          * 2*
* 3*                    These entries create the field specifications         * 3*
* 4*                                    for the file.                         * 4*
* 5*                     Make the appropriate entries and press ENTER.        * 5*
* 6*                                                                          * 6*
* 7*     Field name:  DESCRIPT                                                * 7*
* 8*     Start loc:   11                                                      * 8*
* 9*     Int. format: C          (P-packed, B-binary, C-character, Z-zoned, U-unsigned) * 9*
*10*     Int. length: 40         (# disk pos - max: P-8, B-4, C-132, Z-15, U-15)       *10*
* 1*     Ext. length: 40         (only if not calculated from int. length)            * 1*
* 2*     Decimal pos: 0          (0-9, define for numeric fields only)                * 2*
* 3*     Occurrences: 01         (number of times this field repeated)                * 3*
* 4*     Report code: 0          (0-report of field allowed, 1-not allowed)           * 4*
* 5*     Update code: 0          (0-update of field allowed, 1-not allowed)           * 5*
* 6*     Dsplay code: 0          (0-blank after, 1-no blank after, 2-display only)    * 6*
* 7*     0-suppress : 0          (0-no zero suppress,1-suppress leading zero,2-* prot) * 7*
* 8*     Sign contrl: 0          (0-no sign,1-trailing minus,2-CR on -,3-DB on -)      * 8*
* 9*     Dol/comma  : 0          (0-none  1-","  2-"$"  3-"$" and ",")                * 9*
*20*     Binary edit: 0          (0-hex, 1-CVB ,used only for INTERNAL FORMAT=B)       *20*
* 1*     Date stamp:  0          (0-no, 1-yes)                                        * 1*
* 2*     Cum. field:  ********   (Enter field name to be accumulator)                 * 2*
* 3*     Field alias: ********************************* (alternate name-used by INQUIRY) * 3*
* 4*                  Press PF16 to return to Control File Utility menu.           * 4*
*  *                                                                          *  *
*****************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
*****************************************************************************
```

Fig 12. Field Specification for DESCRIPT

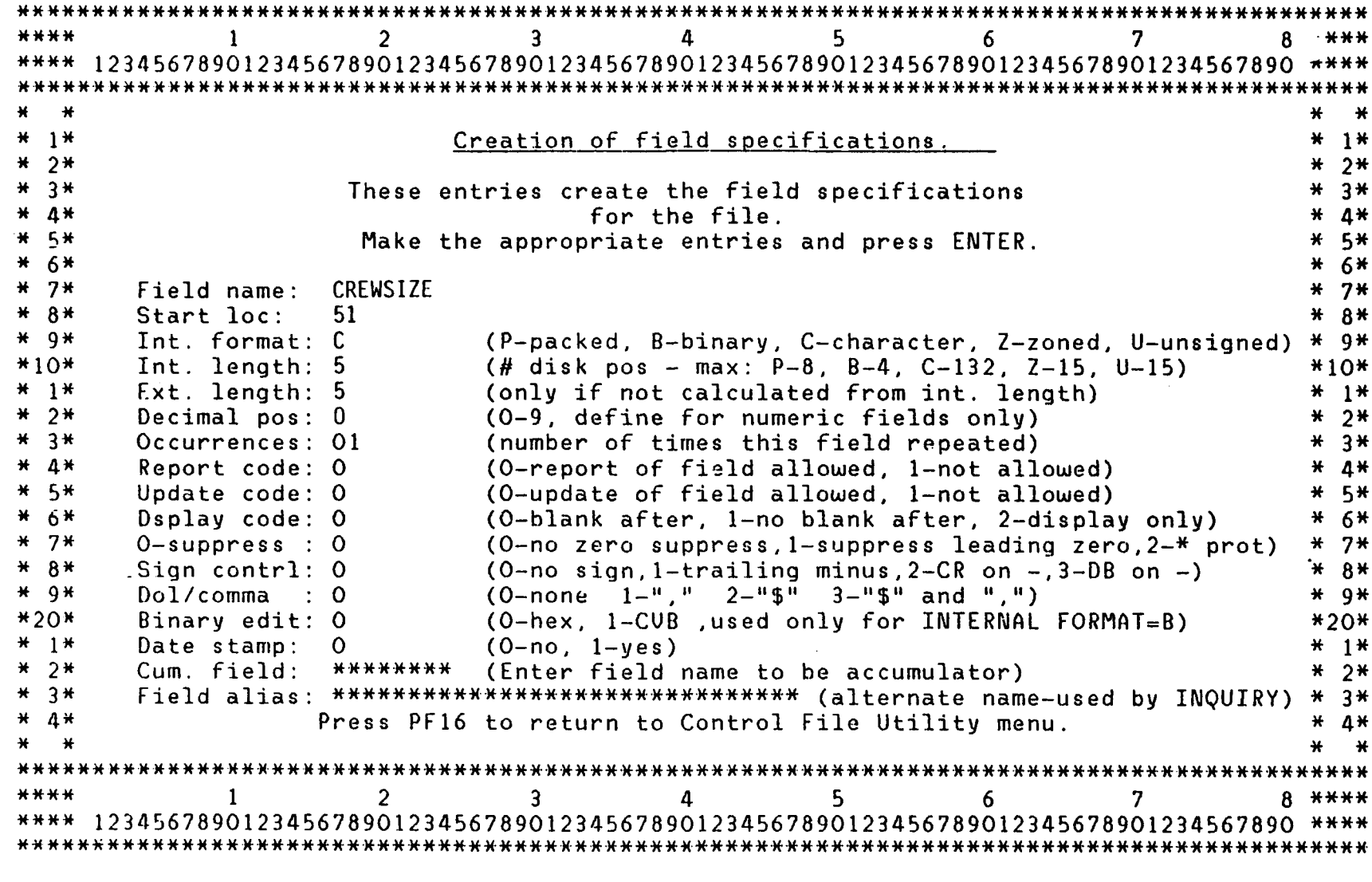


Fig 13. Field Specification for CREWSIZE

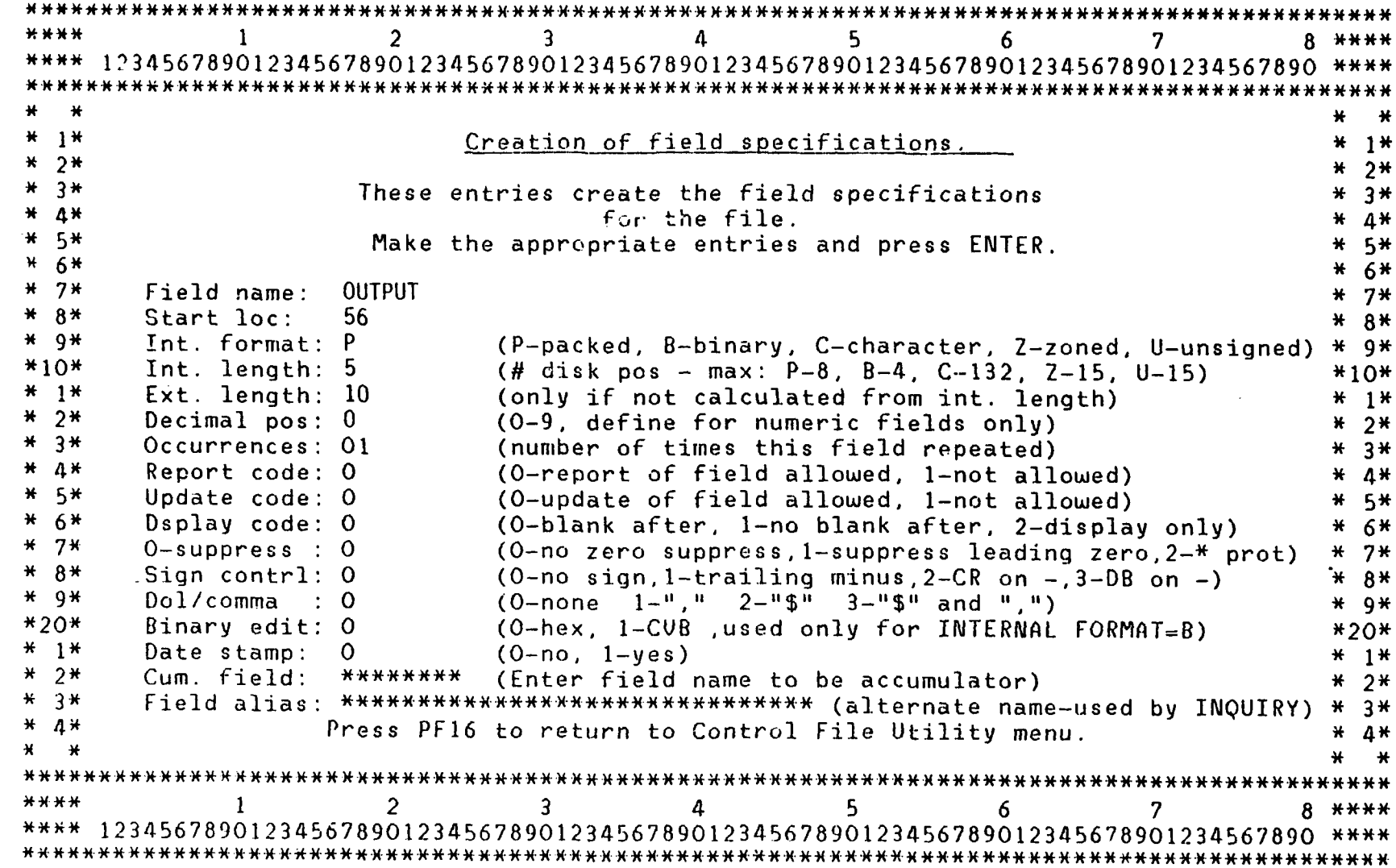


Fig 14. Field Specification for OUTPUT

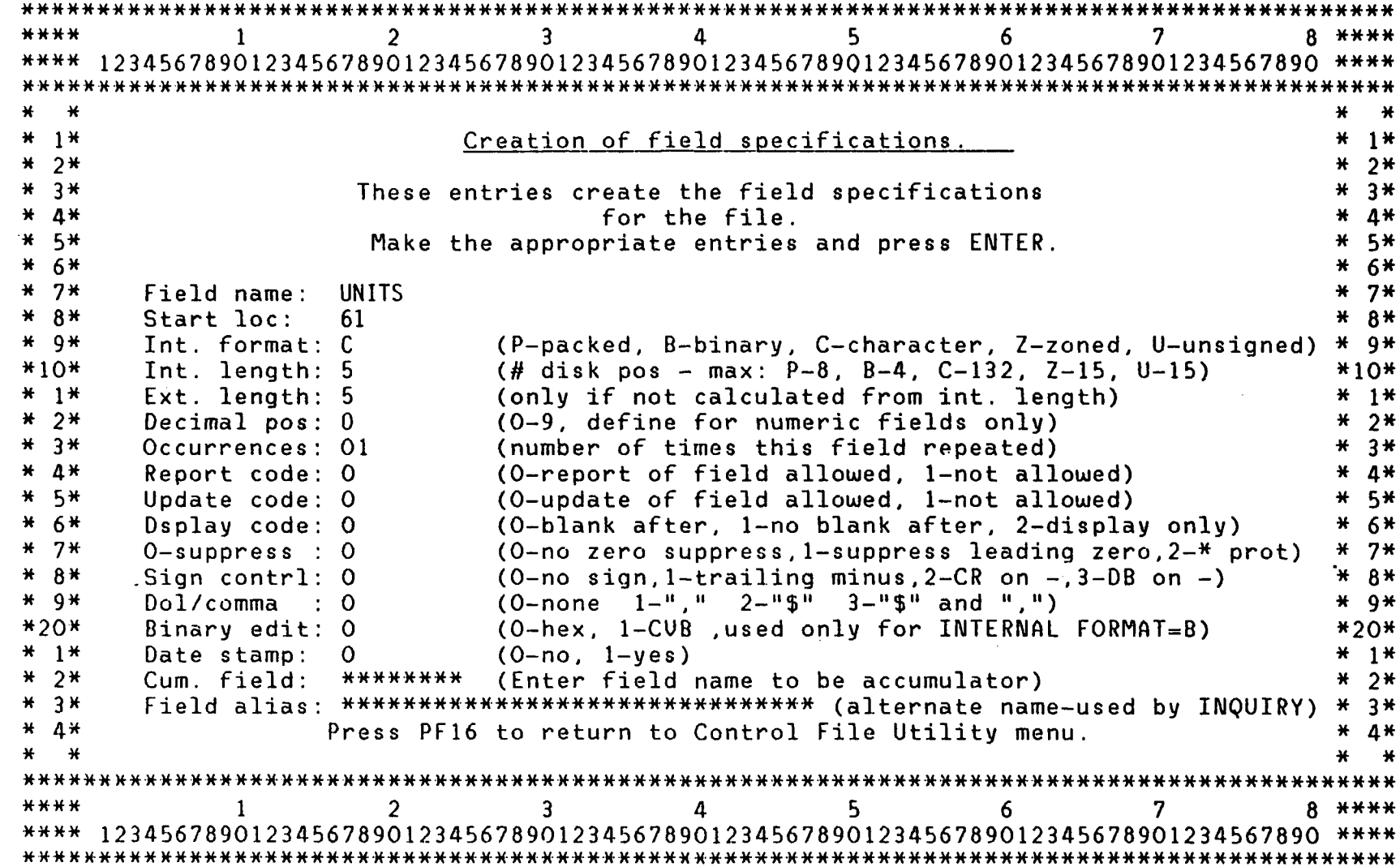


Fig 15. Field Specification for UNITS

```
*****************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
*****************************************************************************
*  *                                                                        *  *
* 1*                      Creation of field specifications.                 * 1*
* 2*                                                                        * 2*
* 3*                  These entries create the field specifications         * 3*
* 4*                                  for the file.                         * 4*
* 5*                   Make the appropriate entries and press ENTER.        * 5*
* 6*                                                                        * 6*
* 7*    Field name:  EQUIP                                                  * 7*
* 8*    Start loc:   66                                                     * 8*
* 9*    Int. format: P          (P-packed, B-binary, C-character, Z-zoned, U-unsigned) * 9*
*10*    Int. length: 6          (# disk pos - max: P-8, B-4, C-132, Z-15, U-15)       *10*
* 1*    Ext. length: 13         (only if not calculated from int. length)            * 1*
* 2*    Decimal pos: 2          (0-9, define for numeric fields only)                * 2*
* 3*    Occurrences: 01         (number of times this field repeated)                * 3*
* 4*    Report code: 0          (0-report of field allowed, 1-not allowed)           * 4*
* 5*    Update code: 0          (0-update of field allowed, 1-not allowed)           * 5*
* 6*    Dsplay code: 0          (0-blank after, 1-no blank after, 2-display only)    * 6*
* 7*    0-suppress : 0          (0-no zero suppress,1-suppress leading zero,2-* prot) * 7*
* 8*    Sign contrl: 0          (0-no sign,1-trailing minus,2-CR on -,3-DB on -)      * 8*
* 9*    Dol/comma  : 0          (0-none  1-","  2-"$"  3-"$" and ",")                * 9*
*20*    Binary edit: 0          (0-hex, 1-CVB ,used only for INTERNAL FORMAT=B)       *20*
* 1*    Date stamp:  0          (0-no, 1-yes)                                        * 1*
* 2*    Cum. field:  ********   (Enter field name to be accumulator)                * 2*
* 3*    Field alias: ********************************* (alternate name-used by INQUIRY) * 3*
* 4*                 Press PF16 to return to Control File Utility menu.           * 4*
*  *                                                                        *  *
*****************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
*****************************************************************************
```

Fig 16. Field Specification for EQUIP

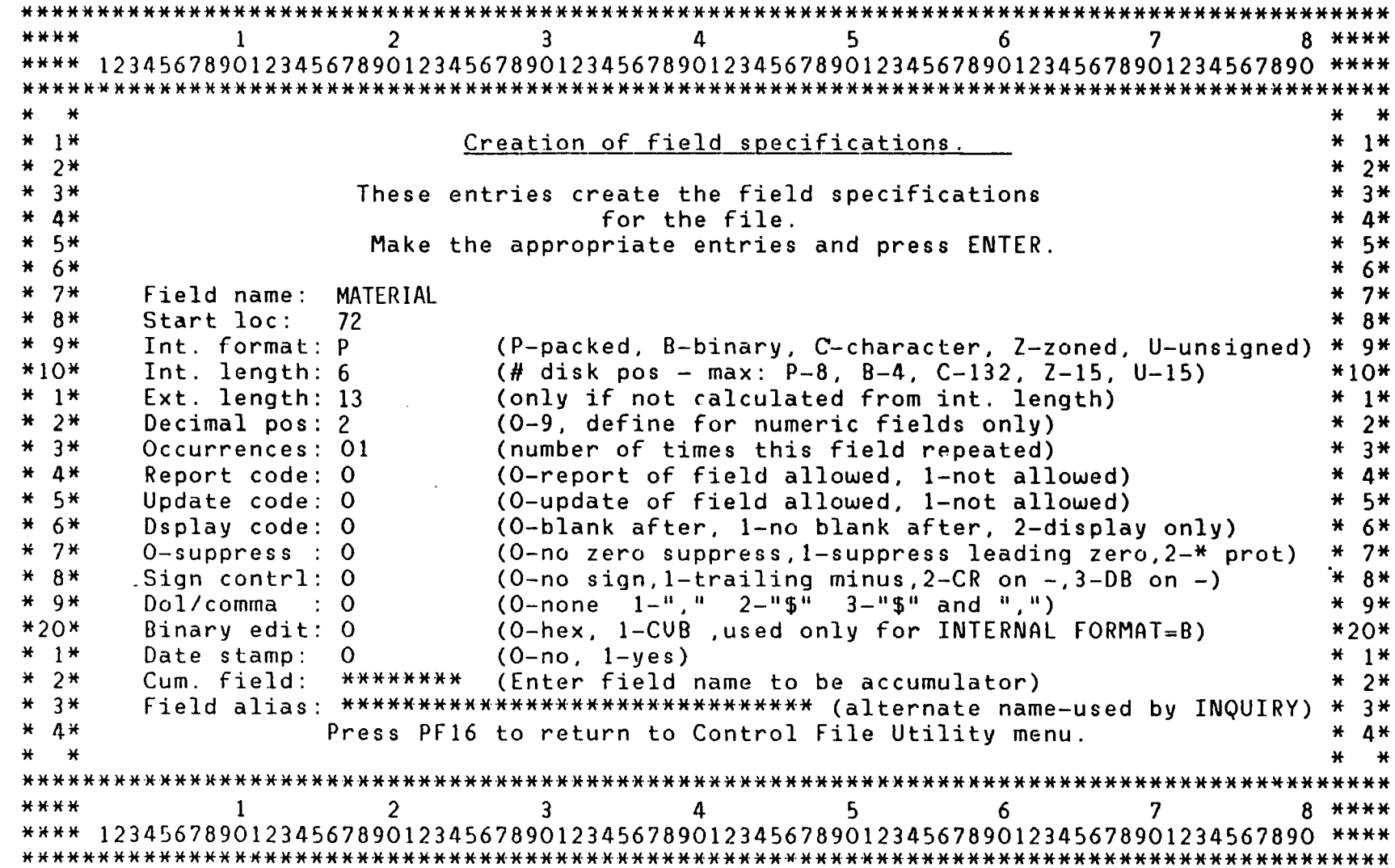


Fig 17. Field Specification for MATERIAL

Fig 18. Field Specification for LABOR

```
**********************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
**********************************************************************************
*  *                                                                             *  *
* 1*                        Creation of field specifications.                    * 1*
* 2*                                                                             * 2*
* 3*                  These entries create the field specifications              * 3*
* 4*                                  for the file.                              * 4*
* 5*                   Make the appropriate entries and press ENTER.             * 5*
* 6*                                                                             * 6*
* 7*     Field name:  BARECOST                                                   * 7*
* 8*     Start loc:   84                                                         * 8*
* 9*     Int. format: P          (P-packed, B-binary, C-character, Z-zoned, U-unsigned) * 9*
*10*     Int. length: 6          (# disk pos - max: P-8, B-4, C-132, Z-15, U-15)  *10*
* 1*     Ext. length: 13         (only if not calculated from int. length)       * 1*
* 2*     Decimal pos: 2          (0-9, define for numeric fields only)           * 2*
* 3*     Occurrences: 01         (number of times this field repeated)           * 3*
* 4*     Report code: 0          (0-report of field allowed, 1-not allowed)      * 4*
* 5*     Update code: 0          (0-update of field allowed, 1-not allowed)      * 5*
* 6*     Dsplay code: 0          (0-blank after, 1-no blank after, 2-display only) * 6*
* 7*     0-suppress : 0          (0-no zero suppress,1-suppress leading zero,2-* prot) * 7*
* 8*     Sign contrl: 0          (0-no sign,1-trailing minus,2-CR on -,3-DB on -) * 8*
* 9*     Dol/comma  : 0          (0-none  1-","  2-"$"  3-"$" and ",")           * 9*
*20*     Binary edit: 0          (0-hex, 1-CVB ,used only for INTERNAL FORMAT=B) *20*
* 1*     Date stamp:  0          (0-no, 1-yes)                                   * 1*
* 2*     Cum. field:  ********   (Enter field name to be accumulator)            * 2*
* 3*     Field alias: ********************************* (alternate name-used by INQUIRY) * 3*
* 4*                  Press PF16 to return to Control File Utility menu.         * 4*
*  *                                                                             *  *
**********************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
**********************************************************************************
```

Fig 19. Field Specification for BARECOST

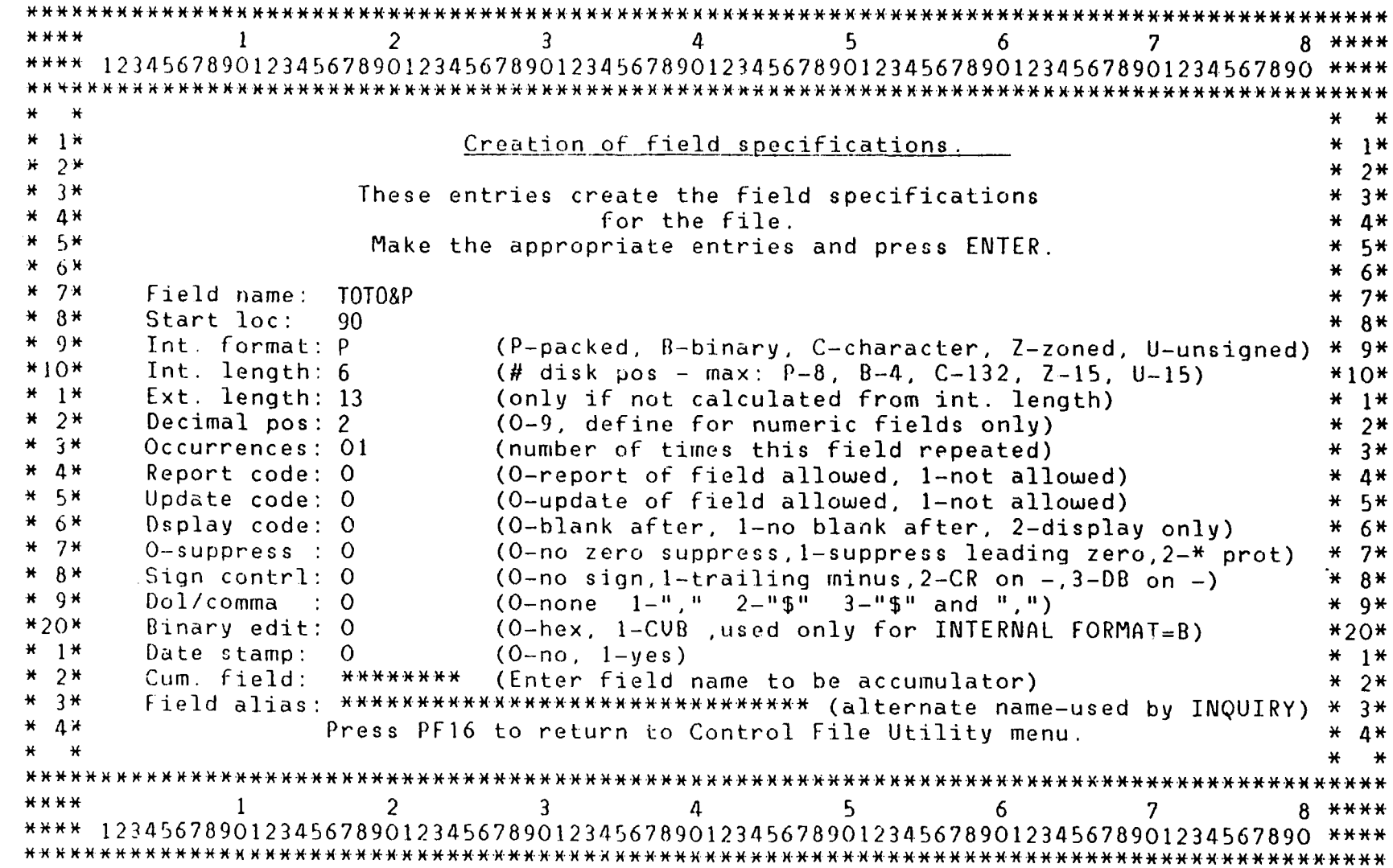


Fig 20. Field Specification for TOTO&P

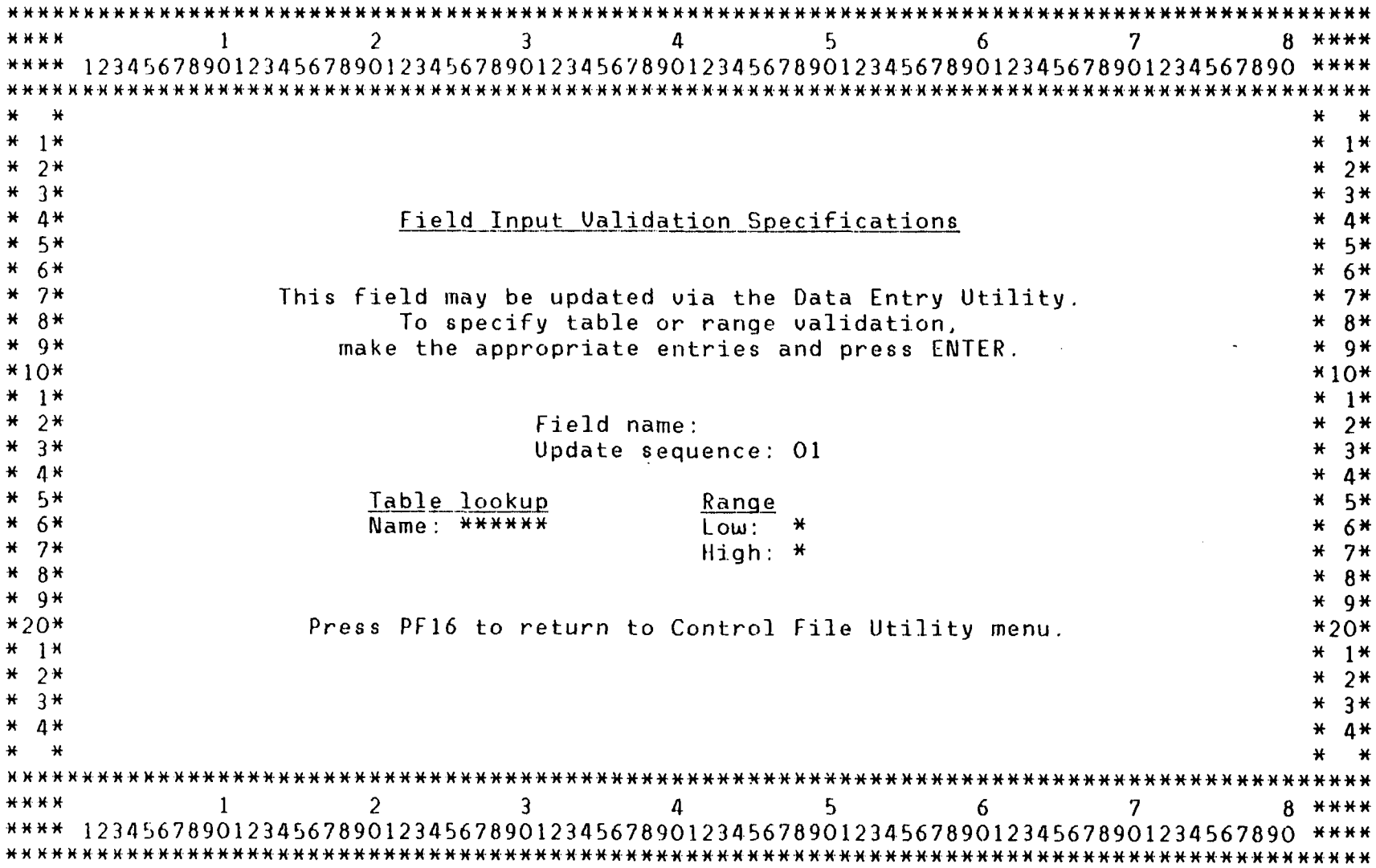


Fig 21. Field Input Validation

Entering Data in the Main Data File:

1. Press the PF key opposite Data Entry, in this example it's PF key 2 (figure 22).

2. The computer now prompts for the data file and the control file as shown in figure 23. Type in the items shown in figure 24 and press "enter".

3. The data entry menu is now on the monitor (figure 25). Create a data file by pressing PF key 2.

4. The output is now created by typing in the information shown in figure 26 and pressing "enter".

5. The next screen shows the data format as the data is entered (figure 27). Figure 28 shows an example data file completed. After each entry press "enter" and a blank format screen will appear similar to figure 27.

6. After entering the data for DIV1 press PF key 16 and create a total of 16 divisions in UCIDATA by repeating steps 3, 4 and 5 (see figure 29).

7. After all divisions are entered the data base is complete. Additions, deletions, or modifications of the existing data can easily be made at any time.

Additions to the Main Data File:

1. Press the PF key opposite Data Entry, in this example it's PF key 2 (figure 22).

2. The next screen now prompts for the data file and the control file. Type in the following items: The data file is DIV1, DIV2, DIV3, ... or DIV16 depending on where the data is placed. The library for the data file is UCIDATA and the control file is ESTIMATE. Press "enter" to continue.

3. Figure 25 is now shown on the monitor. Press PF key 3.

4. The next screen shows the data format (figure 27). Type in the items similar to figure 28 and press "enter" to add the entry to the data file.

5. Press PF key 16 to exit.

Modifications to Existing Data in the Main Data File:

1. Repeat steps 1 and 2 for additions to the data base.

2. Press PF key 4 to modify records on a data file.

3. The next screen (figure 30) must now be completed. The code is the same number used in the code spaces when entering data to the file. In the example the code to enter is 40005. The computer automatically inserts preceeding 0's. Press "enter".

4. The next screen displays the record to be modified (figure 31). All the items can now be changed except the CODE field. After changes are made press "enter" to modify the file. If "enter" is not pressed the changes are not made.

5. Press PF key 16 to exit.

Deletion of Files From the Main Data File:

1. Repeat steps 1 and 2 under additions to the data base.

2. Press PF key 5 to delete records from a data file.

3. The next screen (figure 32) is very similar to the screen used to make modifications. Type in the CODE for the record to be deleted and press "enter". If the CODE can be found in the data the record will be deleted, if not, a message will appear on the screen indicating "record could not be found".

4. Press PF key 16 to exit.

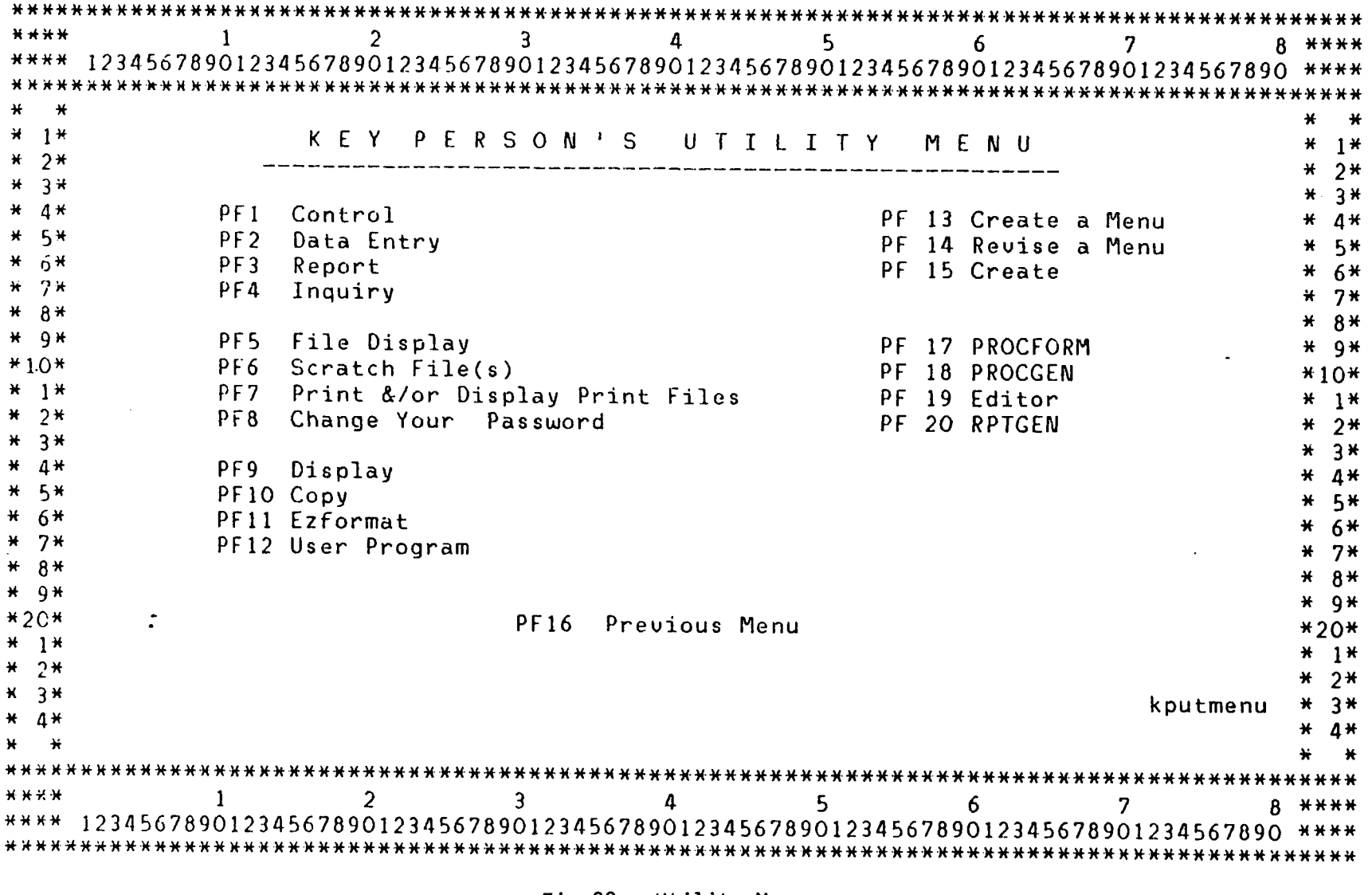


Fig 22. Utility Menu

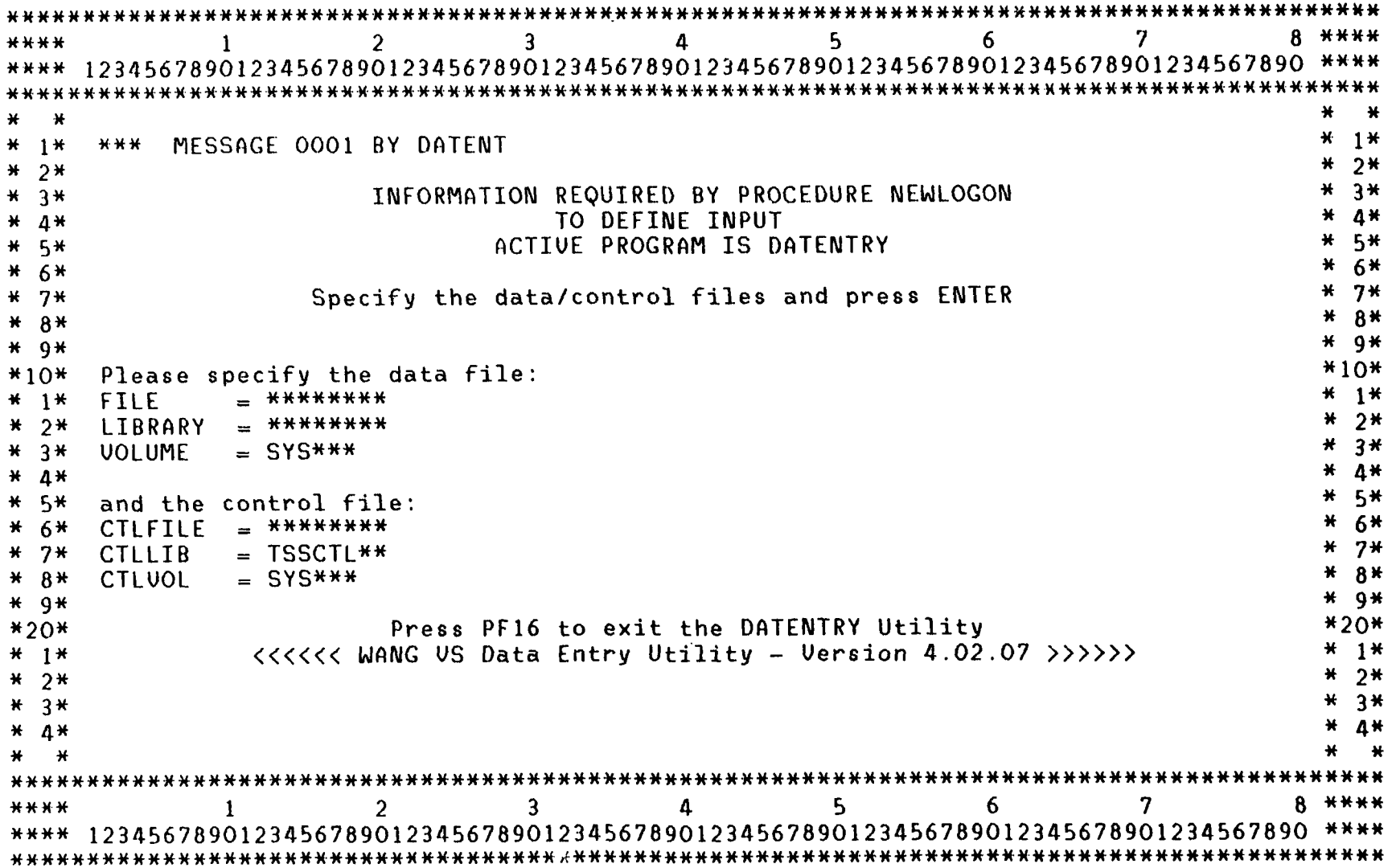


Fig 23. Data Entry Information

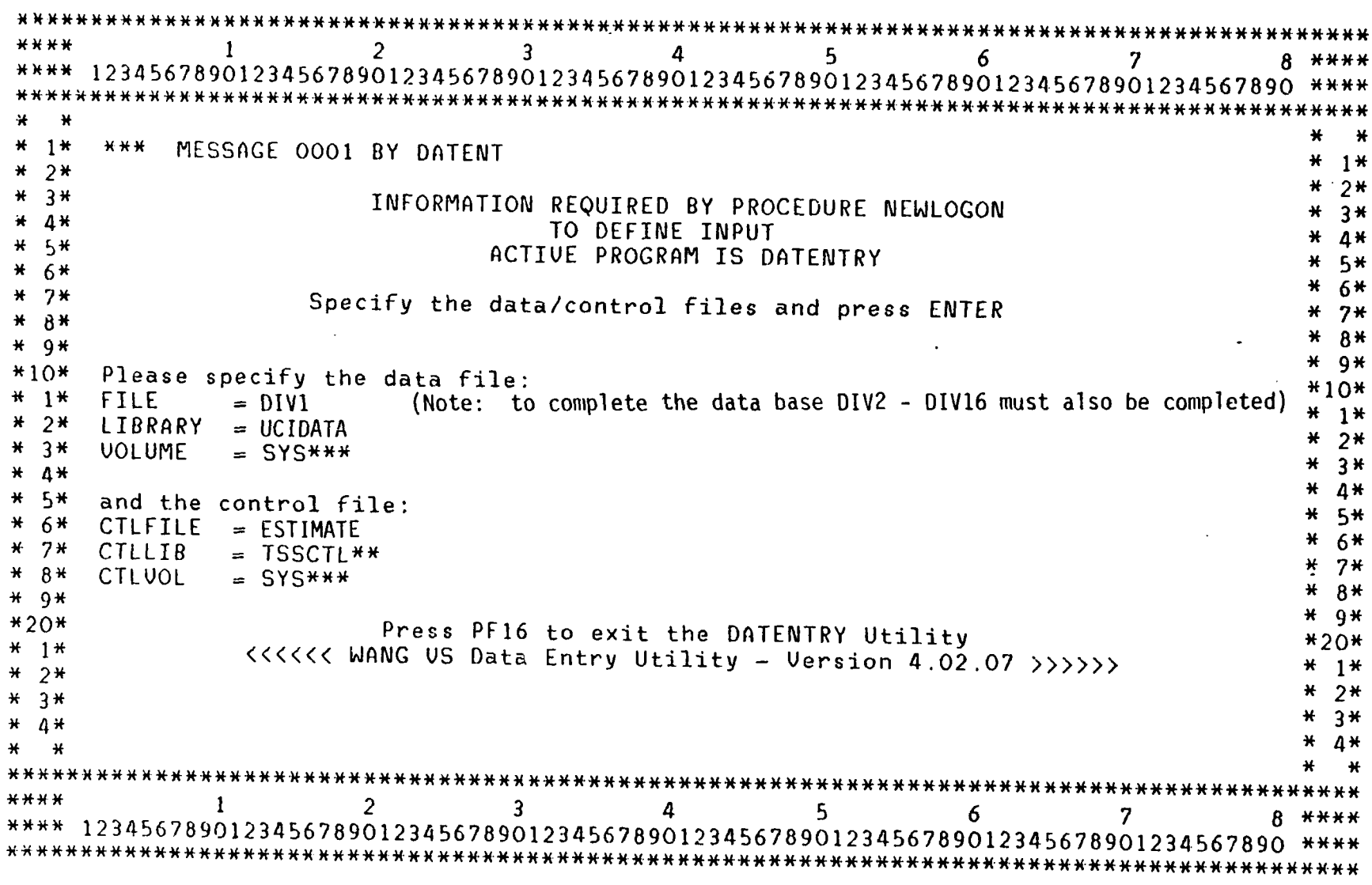


Fig 24. Example Data Entry

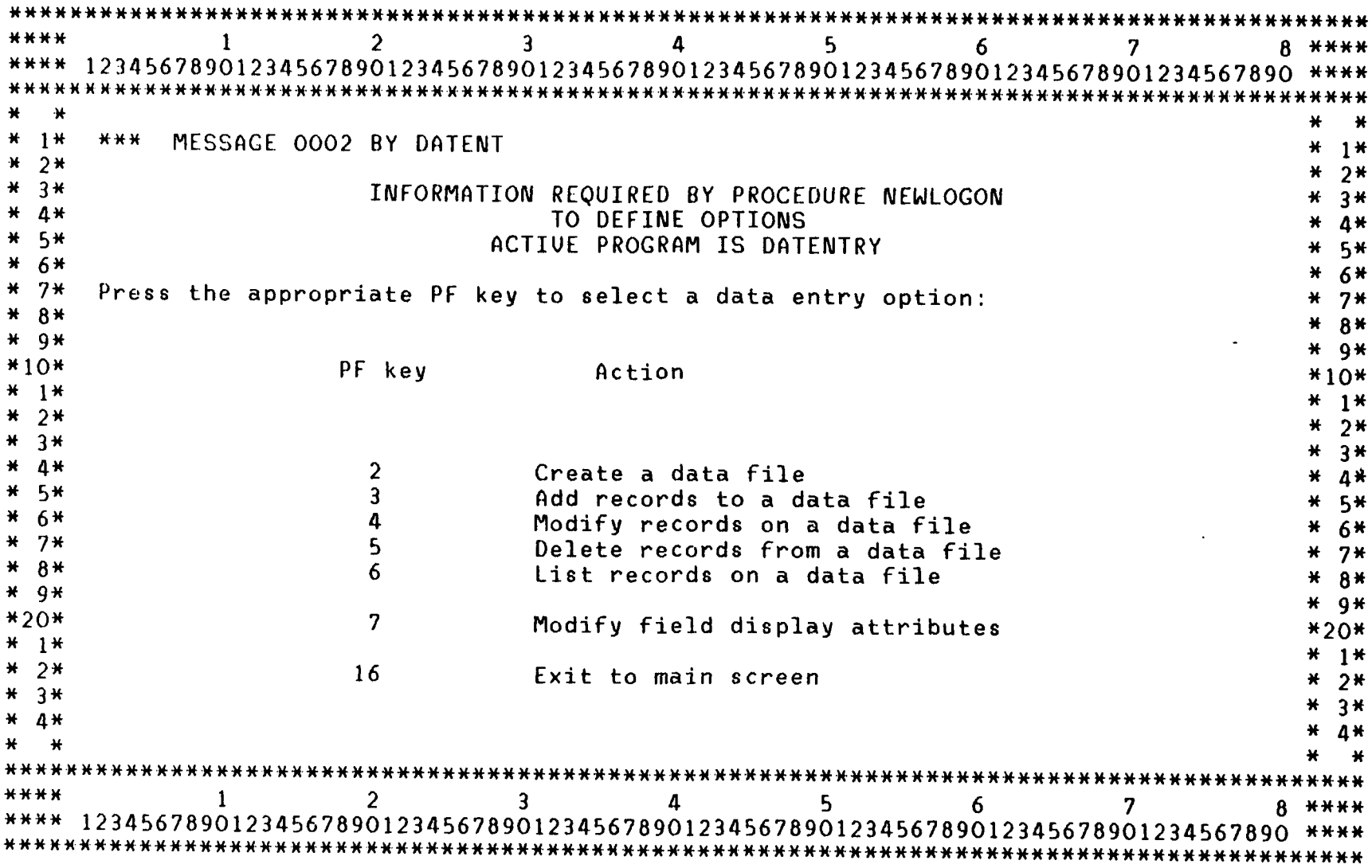
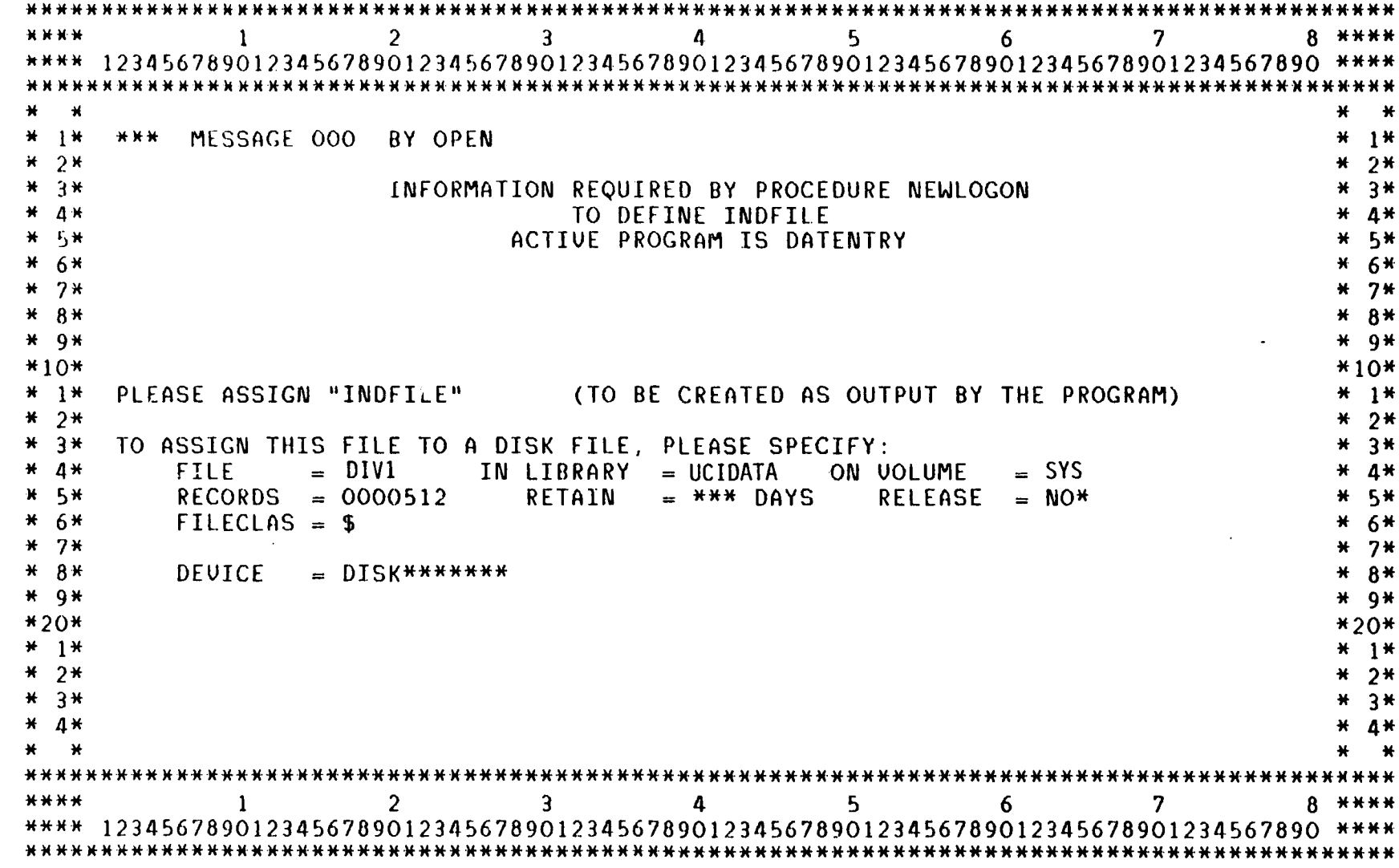


Fig 25. Data Entry Menu



C35

Fig 26. Data Base Output for DIV1

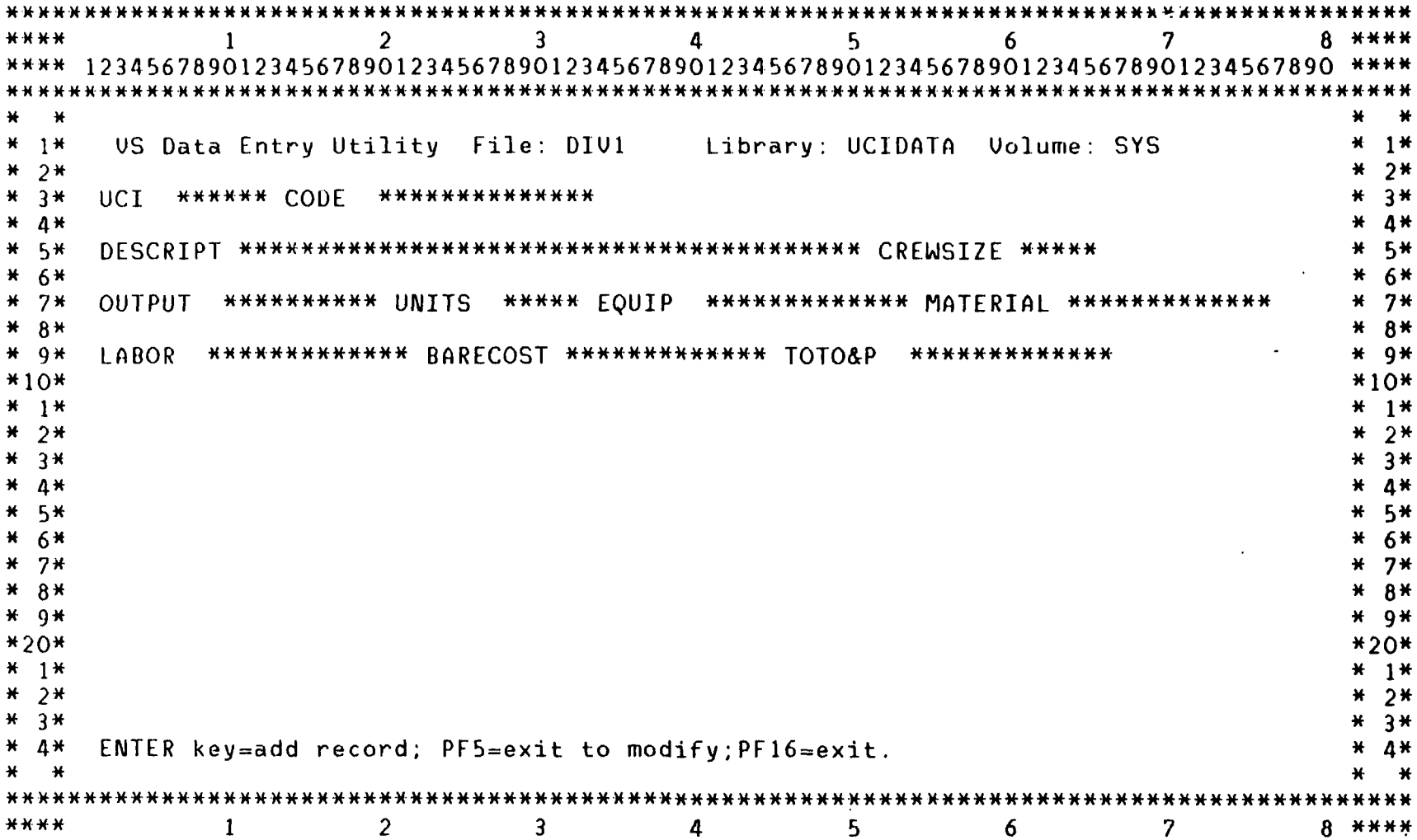


Fig 27. Data Base Format

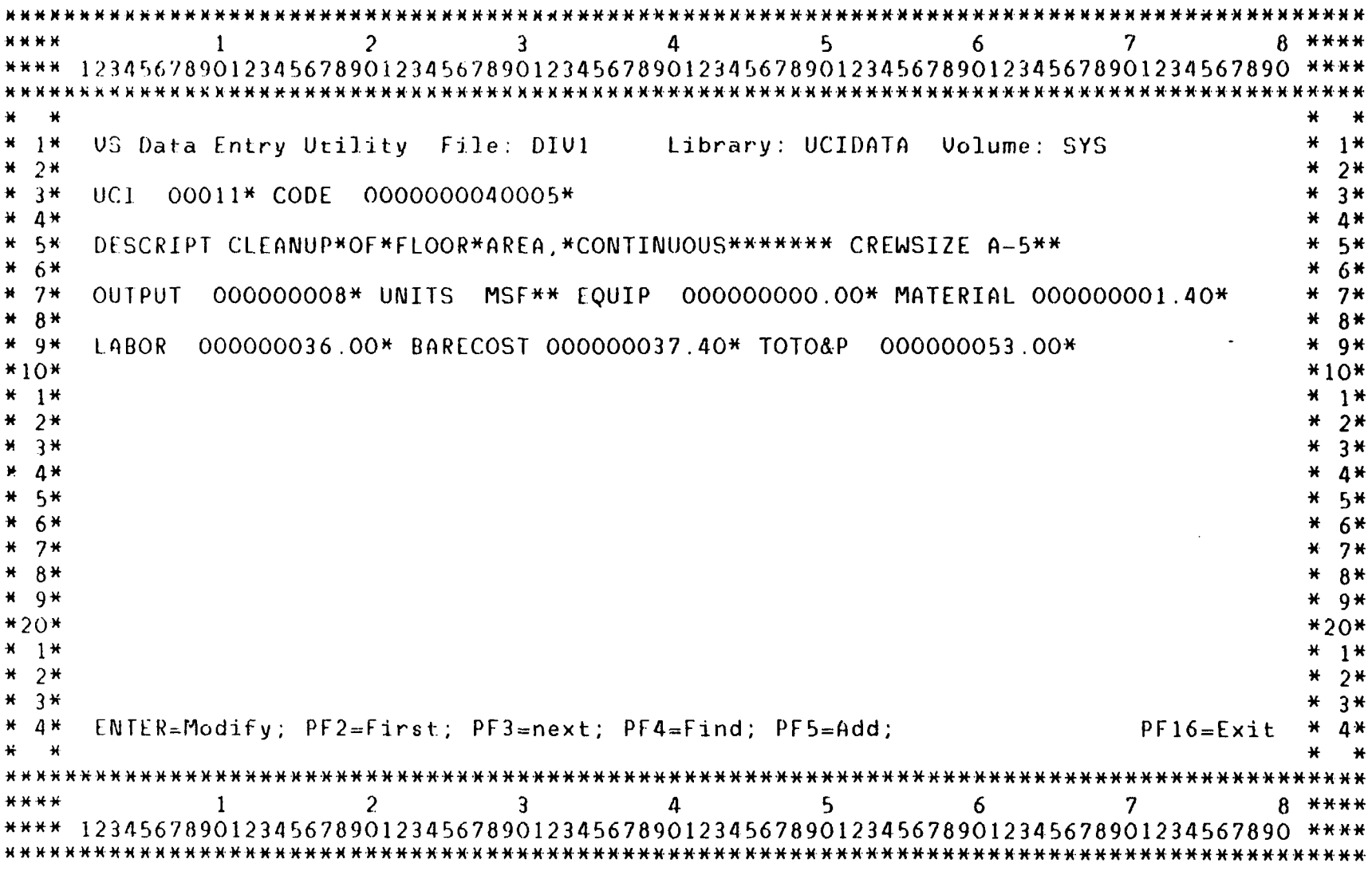


Fig 28. Example Entered in Data Base

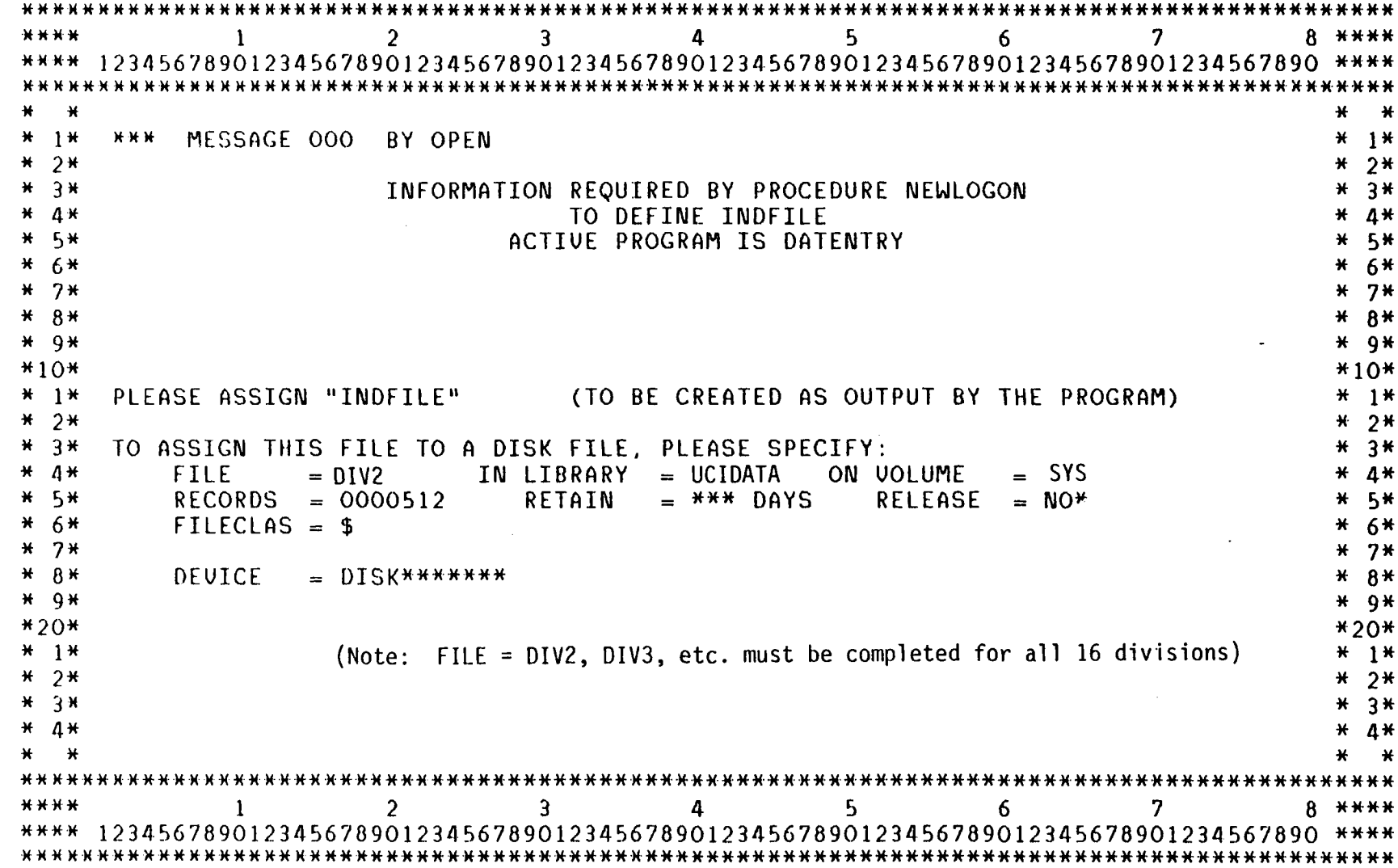


Fig 29. Data Base Output for DIV2

Fig 30. Modification to Existing Data

Fig 31. Example of Existing Data to be Modified

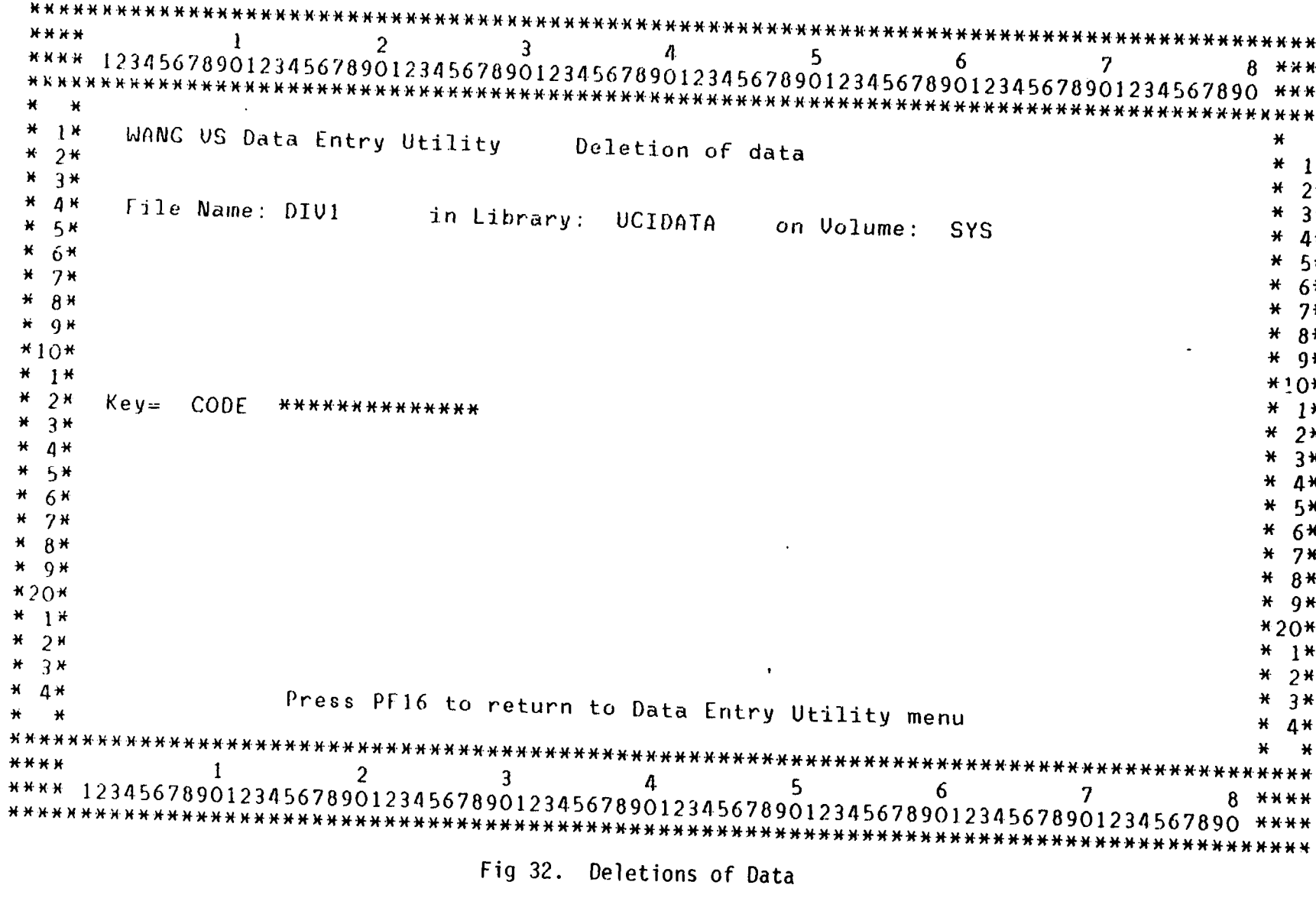


Fig 32. Deletions of Data

Creating a Report Definition for the Main Data File:

1. Press the PF key opposite Report, in this example it's PF key 3 (figure 22).

2. The screen shown in figure 33 is now on the monitor. In order to run a report a report definition must be created. Press PF key 2 to create a report definition.

3. The next screen (figure 34) requires the name of the report. Type in ESTIMATE next to Report ID and press "enter".

4. The next screen (figure 35) requires the name of the primary file to be used in the report. Type in the items shown in figure 35. Press "enter".

5. The Primary File Field Selection screen is now displayed (figure 36). Place an "X" in each item and press "enter".

6. The next screen (figure 37) is not changed. Press "enter".

7. At this point an error message will flash on the screen requiring a change to the field sequence. Press PF key 5 to update the field sequence as shown in figure 38 and press "enter".

8. Press PF key 2 and type in the information shown in figure 39. This is the Report Title Information Screen. Press "enter" to continue.

9. The next screen is Column Headings. Type in the information shown in figure 40 and press "enter".

10. The next screen is Spaces Between Fields (figure 41). No changes should be done to the screen. Press "enter".

11. The Field Sequence screen is now on the monitor. This screen was completed earlier. Check to see if everything is as shown in figure 38 and press "enter".

12. The External Field Size screen is shown in figure 42 and is now displayed on the monitor. Be sure the items read as shown in figure 42 and press "enter".

13. The next screen is Data Edit Options (figure 43). Type an "X" in the (Modify) space and make corrections for the following data fields: UCI, CODE, EQUIP, LABOR, and MATERIAL. Press "enter" to continue.

14. The next screen is the Data Limits. Make no changes to this screen and press "enter".

15. The File Sort screen is next (figure 44). Type in the information shown in figure 44 and press "enter".

16. Make no changes to the Control Fields screen and press "enter".

17. Make no changes to the Summary Options screen and press "enter".

18. Press PF key 16 to exit back to the Utility Menu.

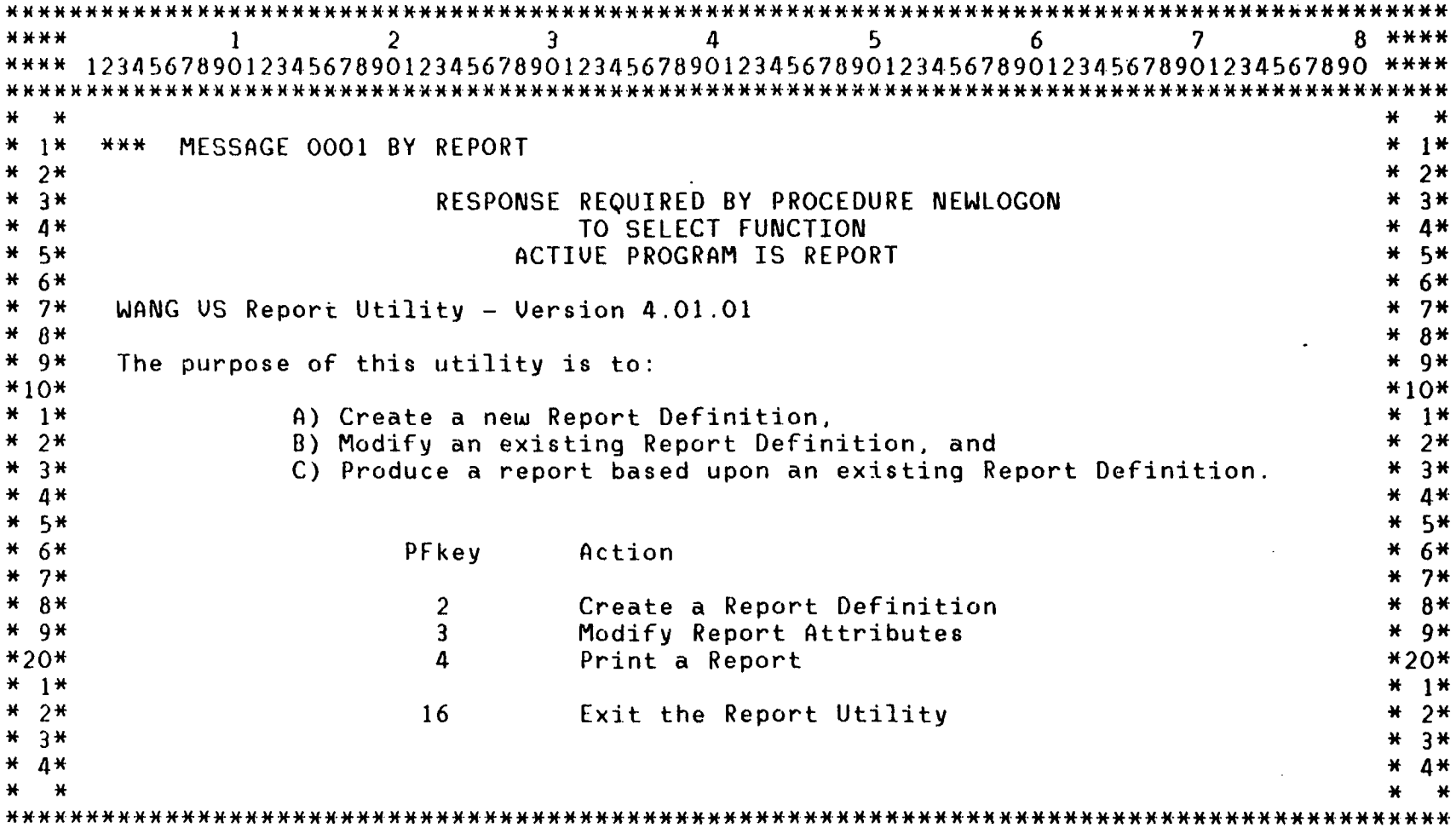


Fig 33. Report Utility Menu

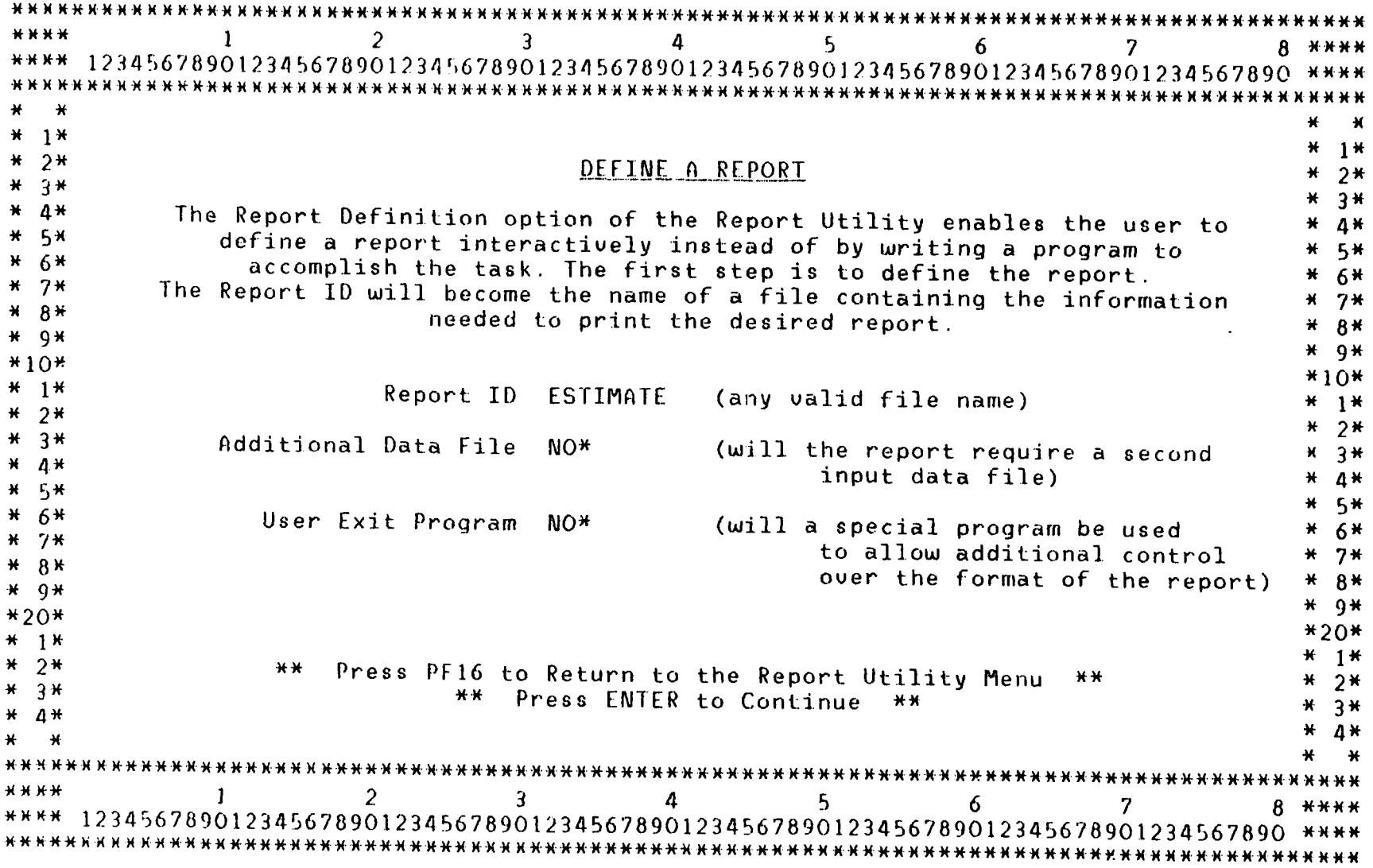


Fig 34. Report Definition

Fig 35. Primary Data File Selection

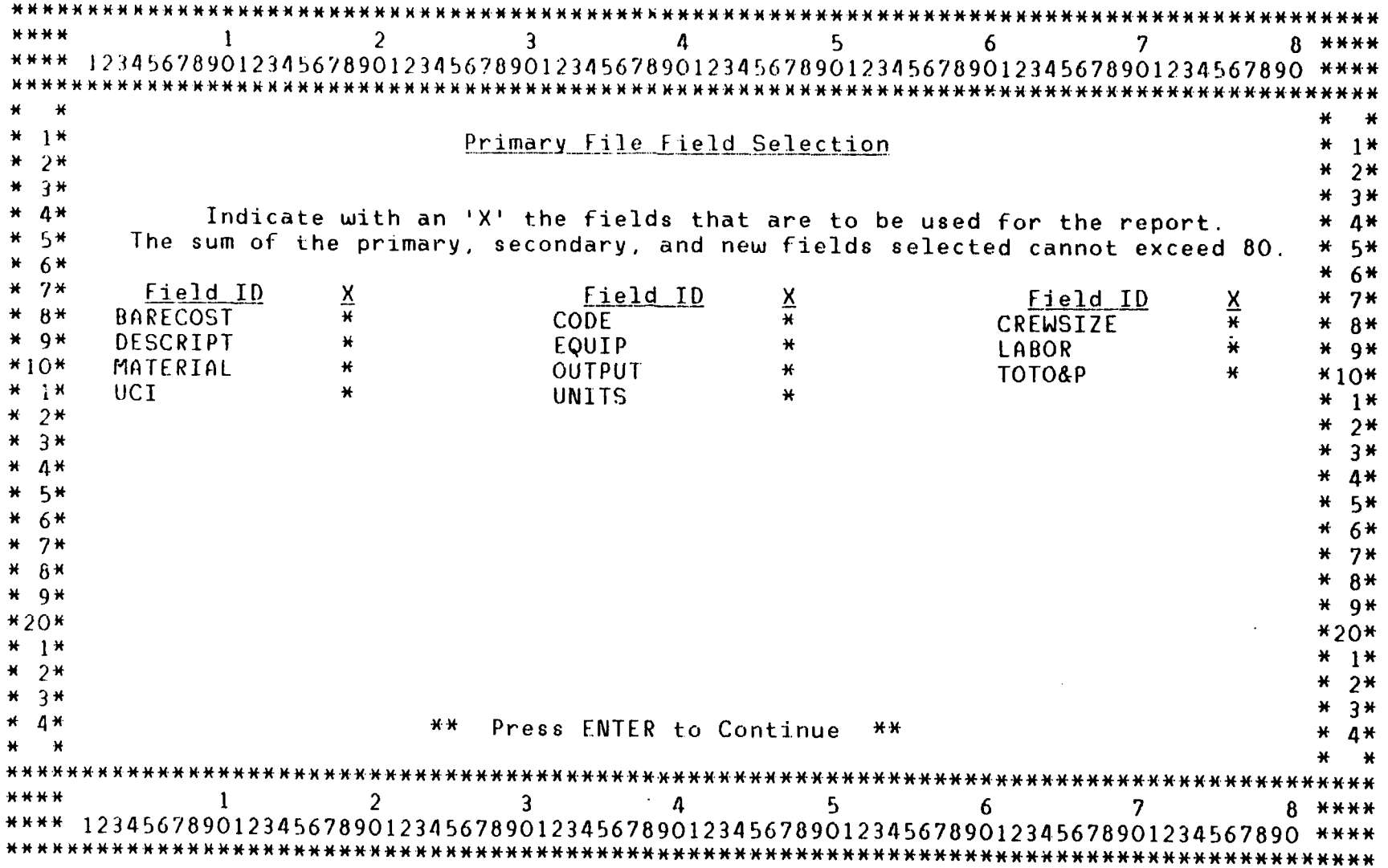


Fig 36. Primary Field Selection

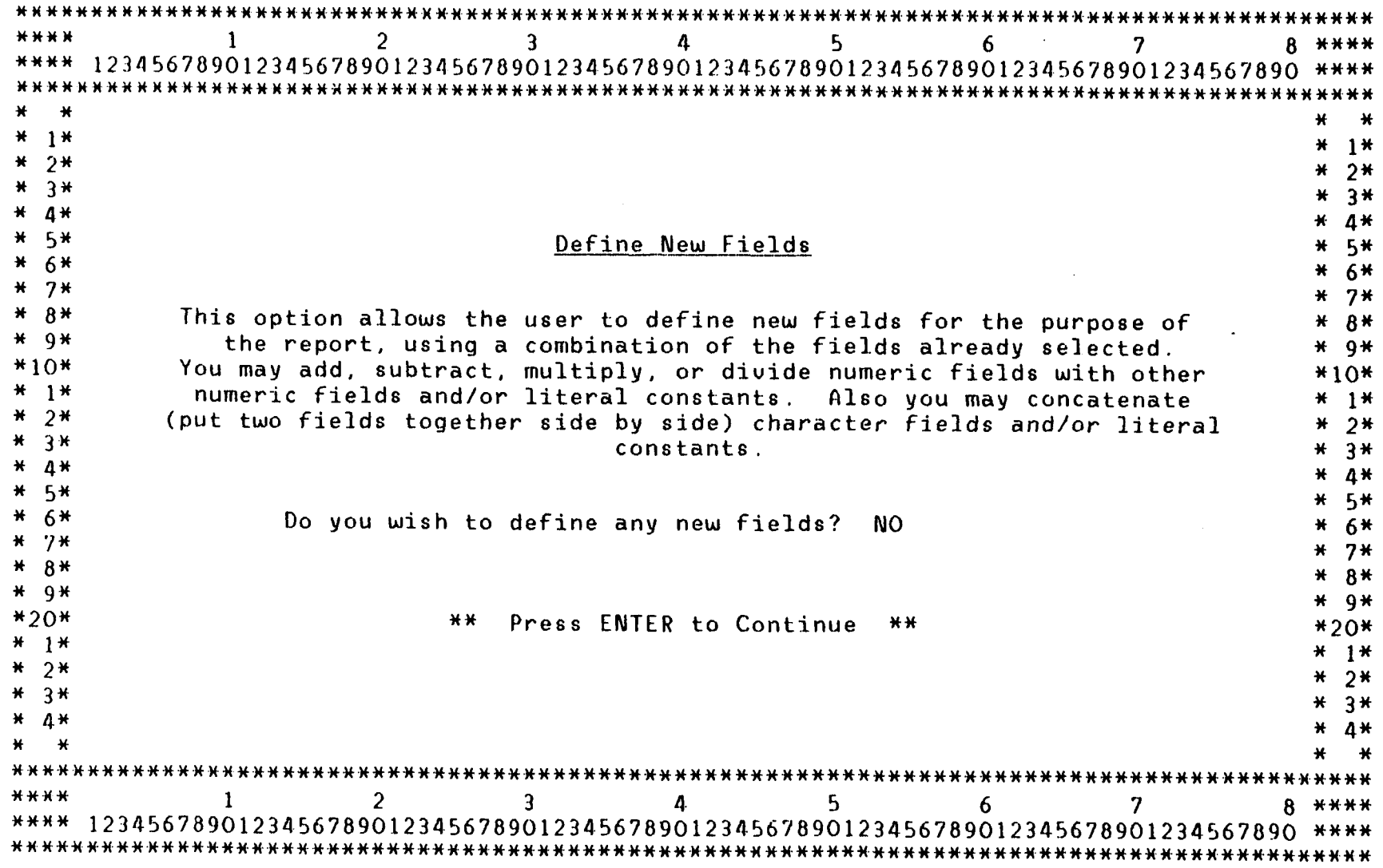


Fig 37. Define New Fields

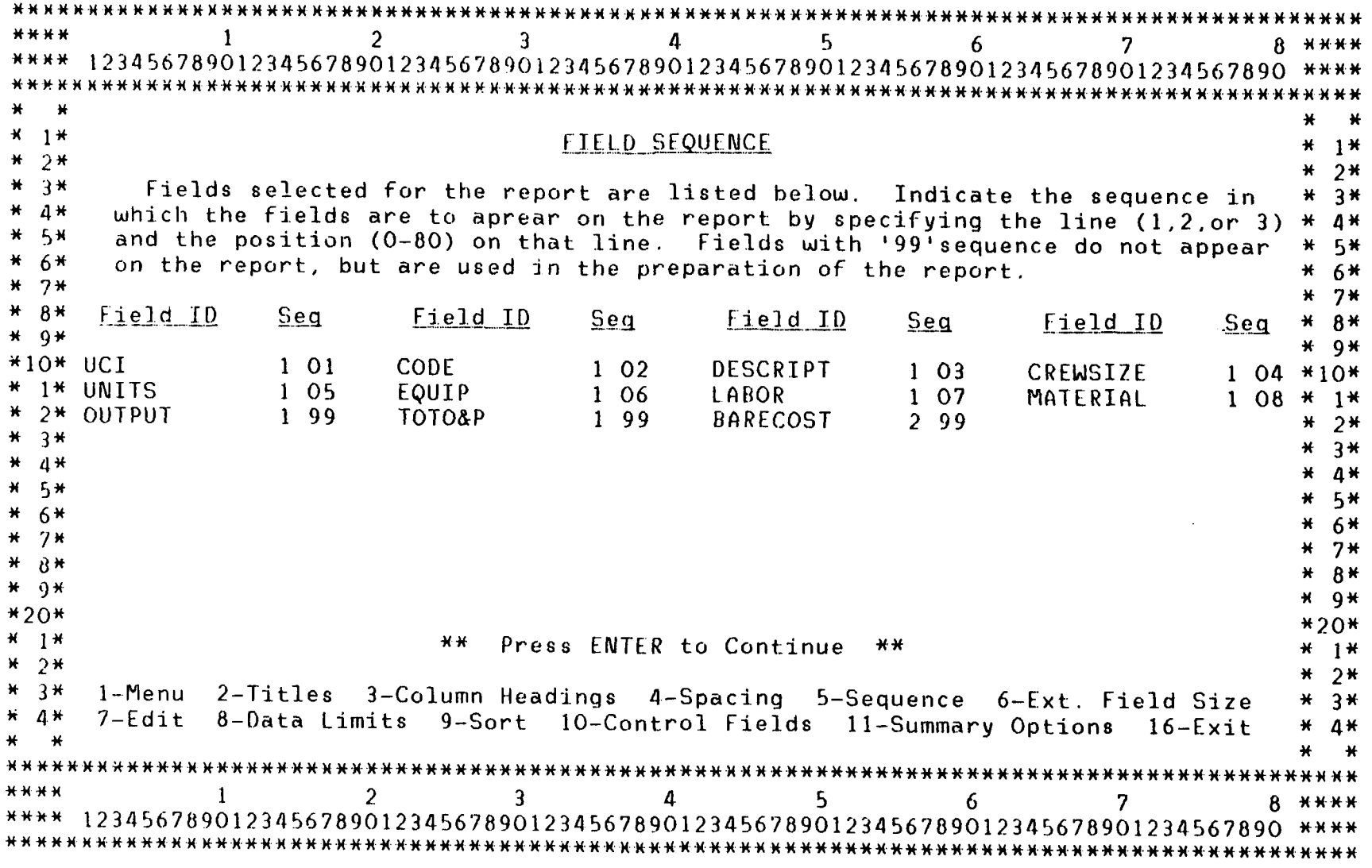


Fig 38. Field Sequence

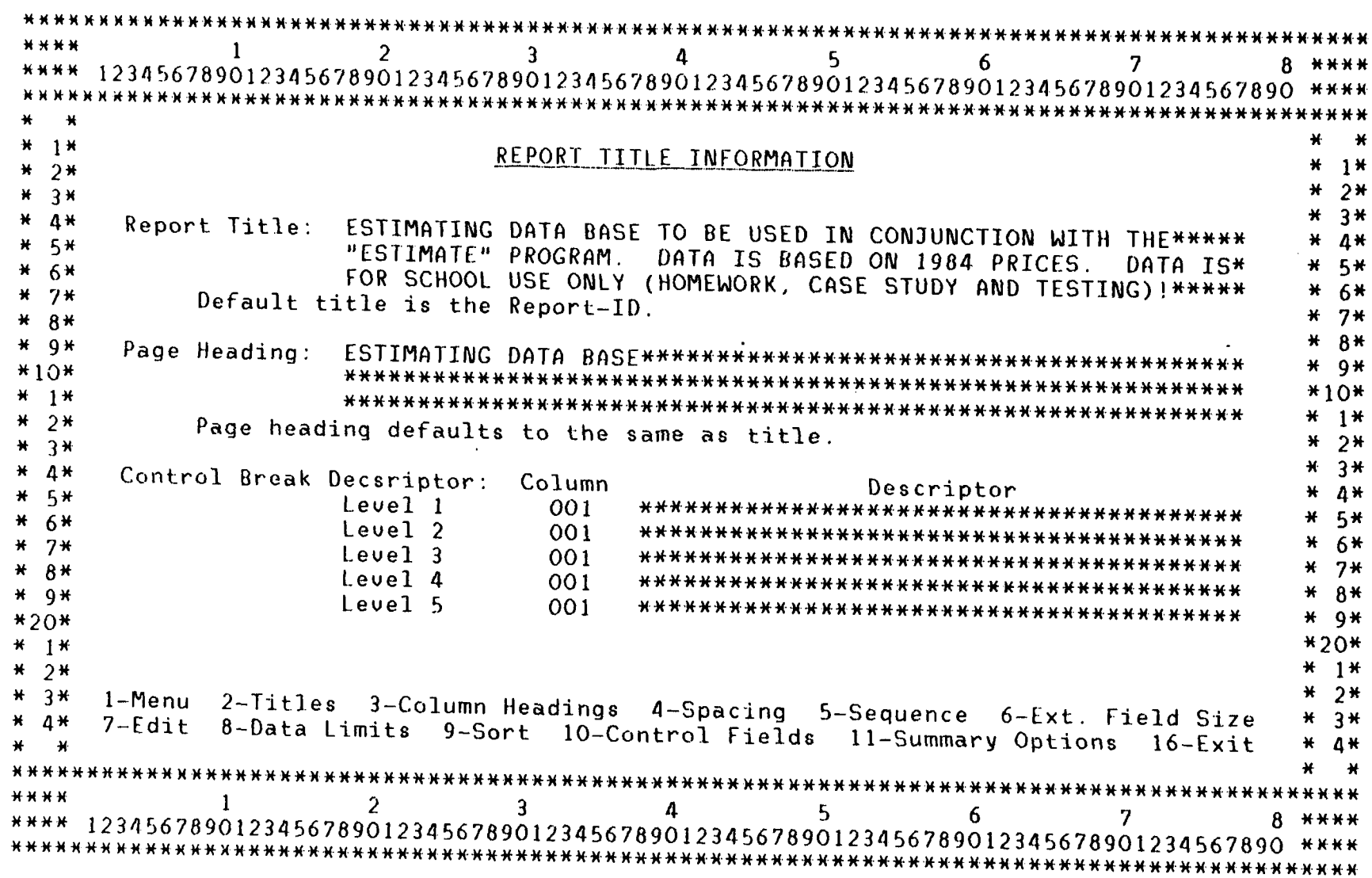


Fig 39. Report Title Information

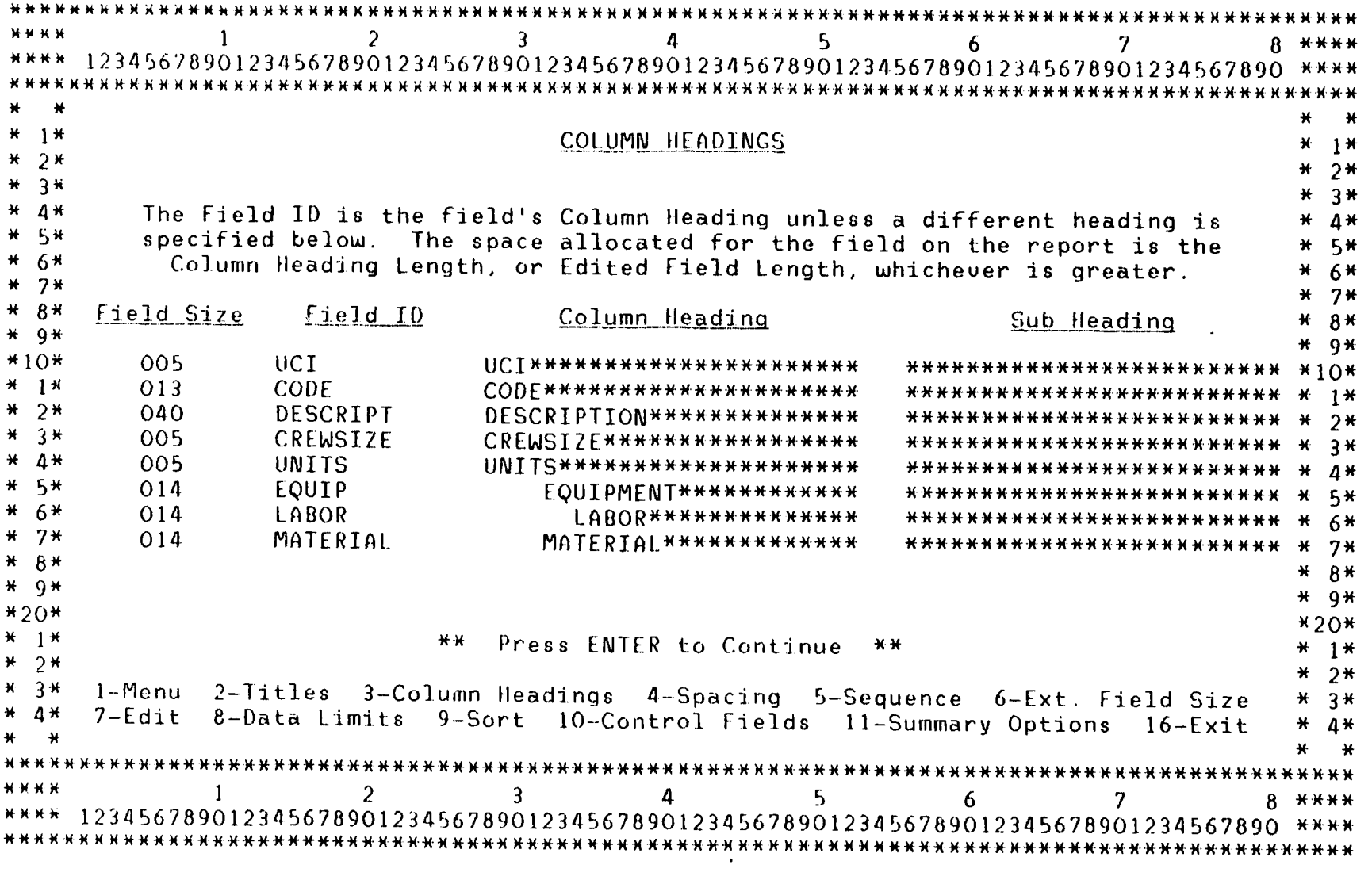


Fig 40. Column Headings

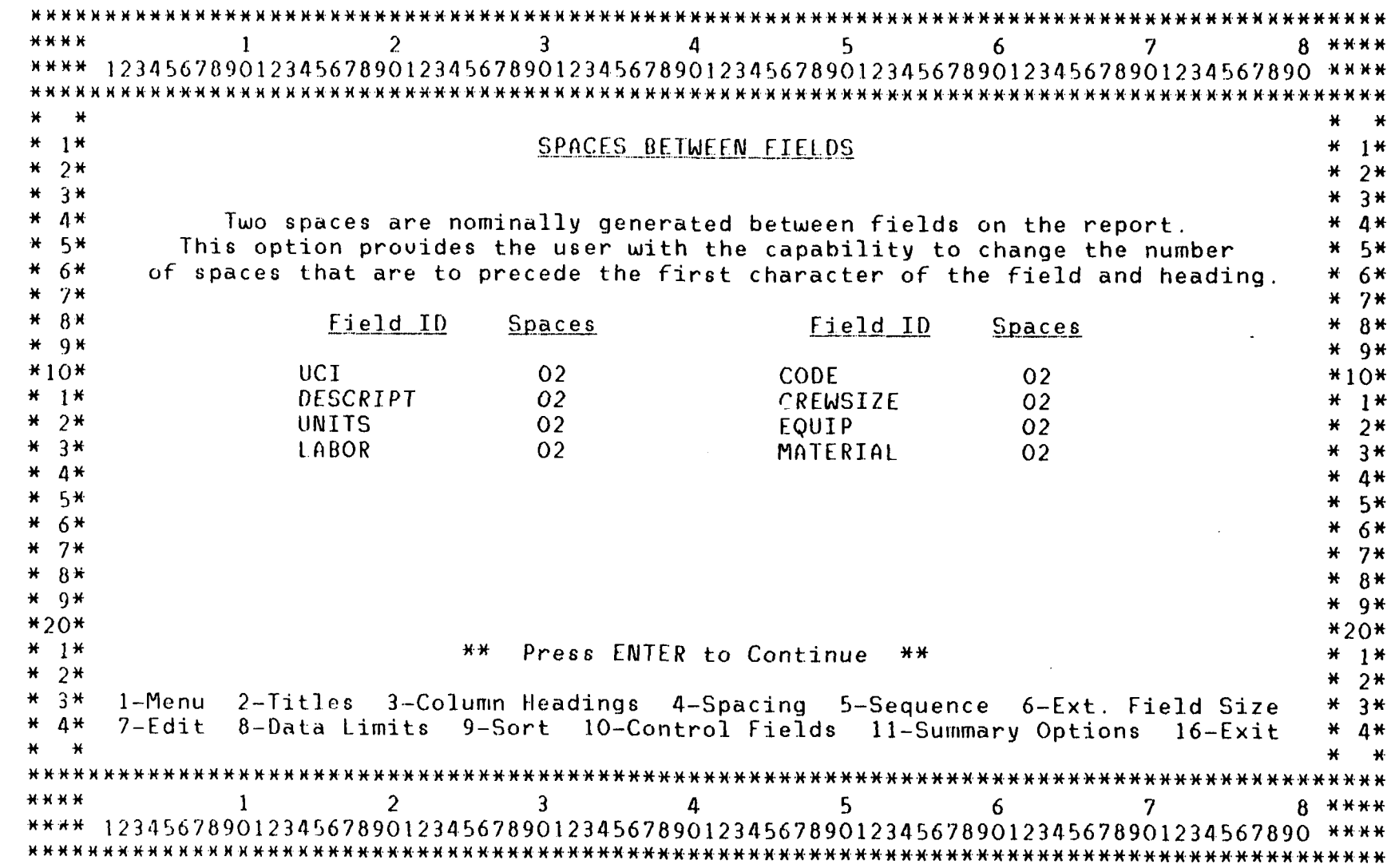


Fig 41. Spaces Between Fields

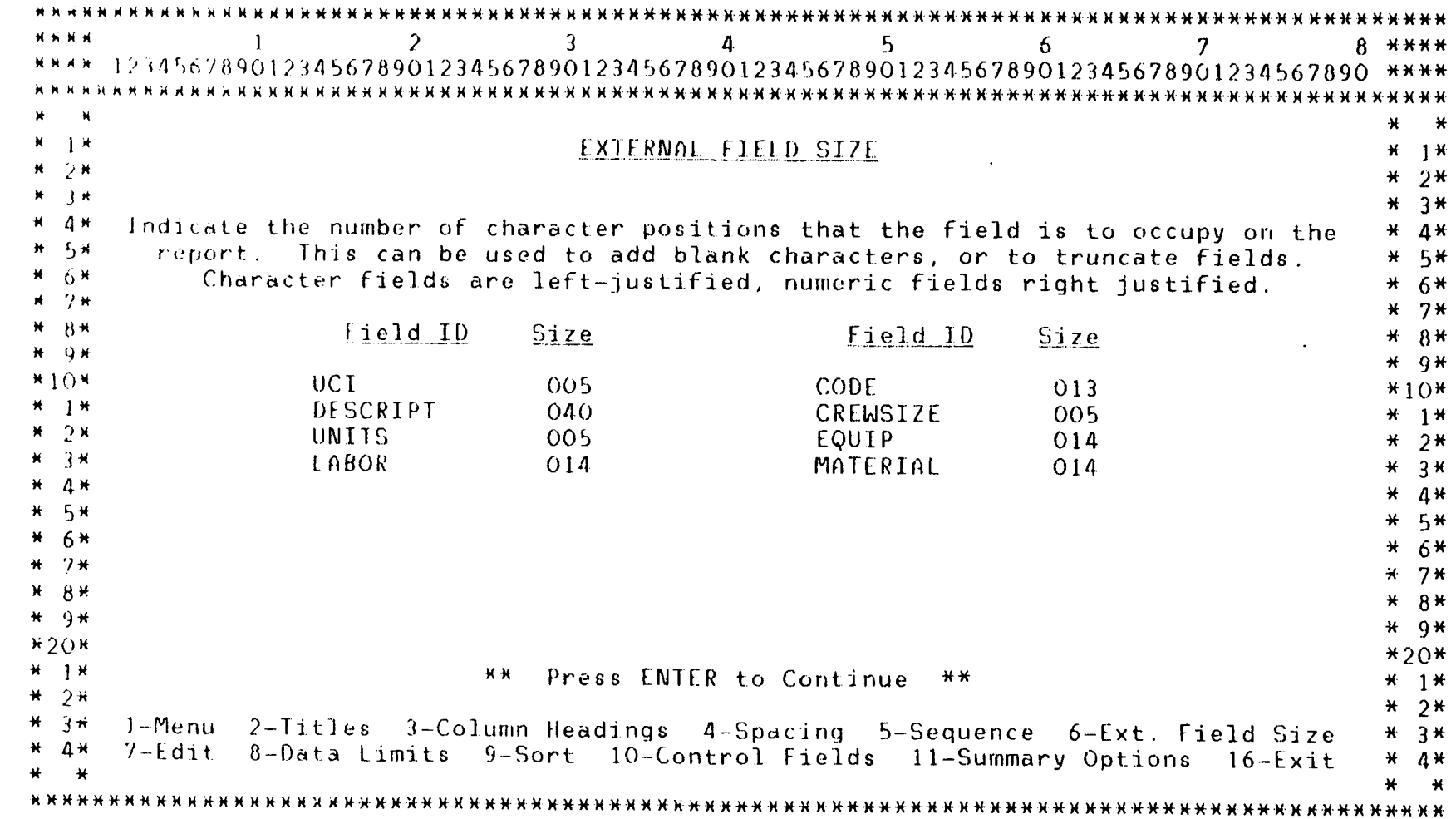


Fig 42. External Field Size

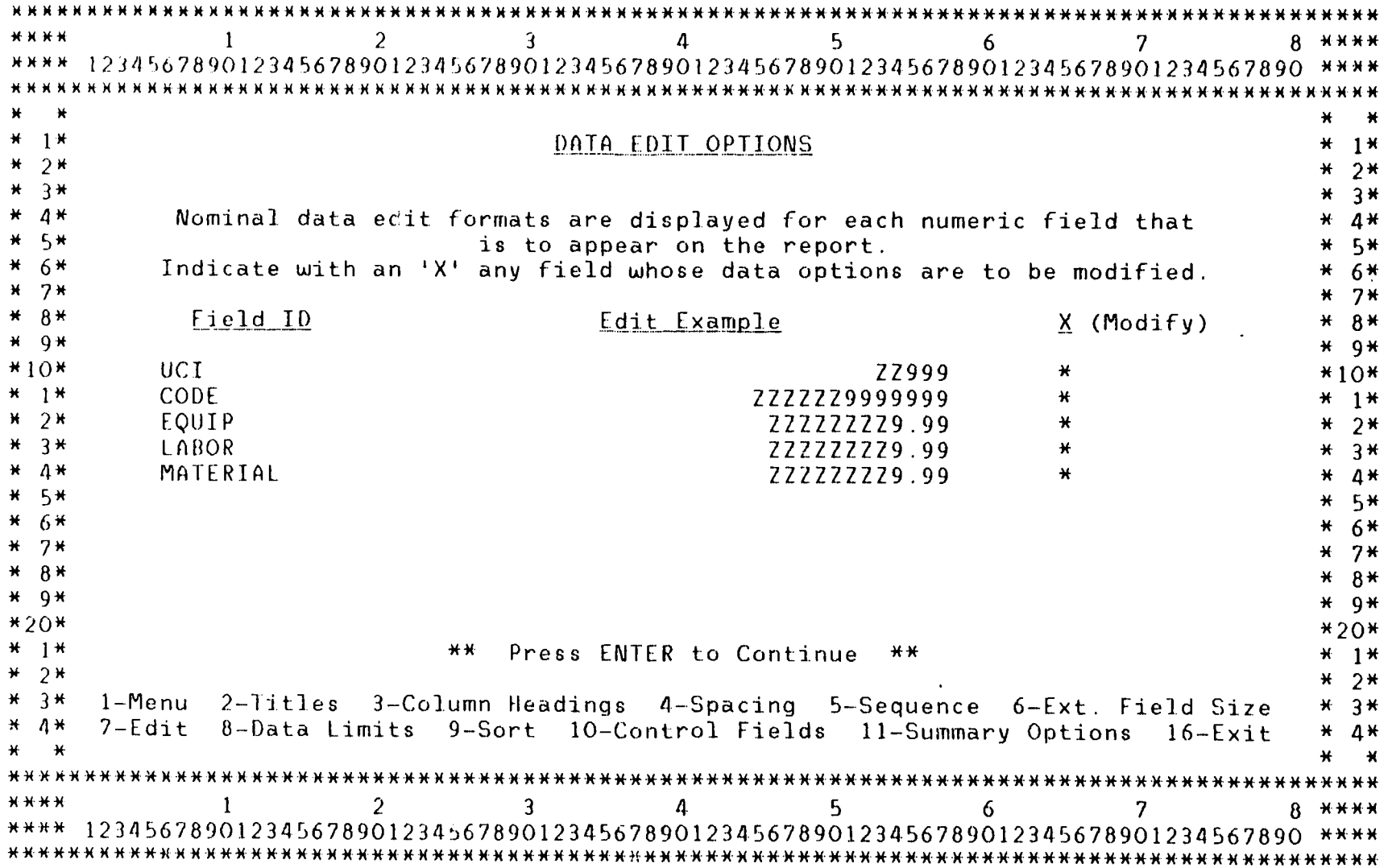


Fig 43. Data Edit Options

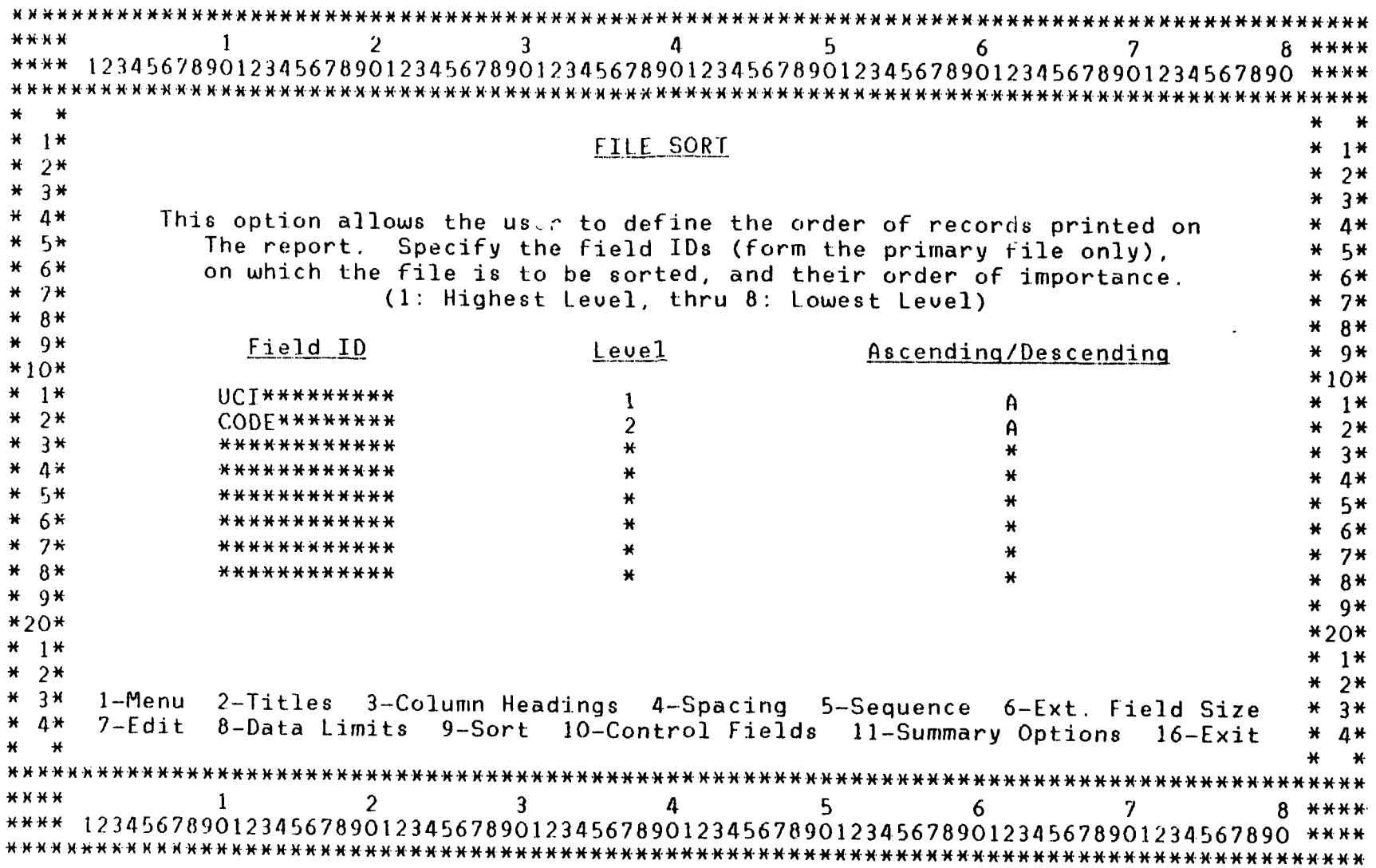


Fig 44. File Sort

Running a Report on the Main Data File:

1. Create a report definition as described earlier.

2. Press PF key 3 to generate a report.

3. The Report screen is now on the monitor (figure 33). Press PF key 4 to print a report. The report will display on the screen before an actual print can be generated.

4. The next screen prompts for the Report ID as shown in figure 45. Type in Report ID = ESTIMATE and change the last line where Print Line Spacing = 000 to 1 (blank) (blank) and press "enter".

5. The next screen prompts for the data file used in the report (figure 46). Type in FILE = (filename) and IN LIBRARY = UCIDATA to run a report on all items in division 1 of the data base. Press "enter" to continue.

6. The next screen displays an example division in a report oriented format as shown in figure 47. To print this report follow standard procedures for the particular system in use.

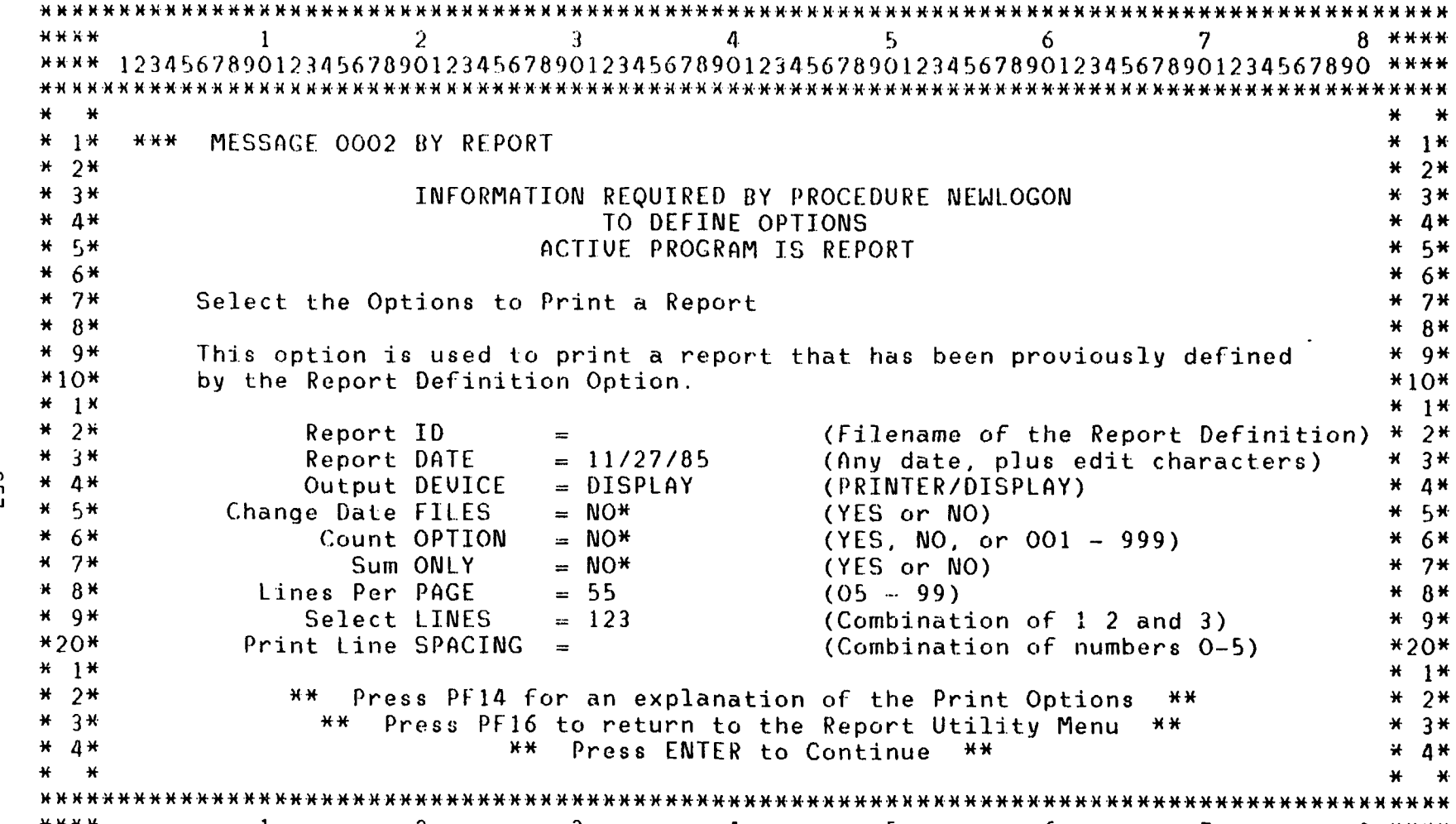


Fig 45. Report Information

```
**********************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
**********************************************************************************
*  *                                                                             *  *
* 1*  ***  MESSAGE RO14 BY OPEN                                                  * 1*
* 2*                                                                             * 2*
* 3*                      CORRECTION REQUIRED BY PROCEDURE NEWLOGON               * 3*
* 4*                                 TO DEFINE INPUT                             * 4*
* 5*                            ACTIVE PROGRAM IS SORT                           * 5*
* 6*                                                                             * 6*
* 7*  FILE SPECIFIED NOT FOUND IN LIBRARY.                                       * 7*
* 8*  PLEASE RESPECIFY FILENAME.                                                 * 8*
* 9*                                                                             * 9*
*10*                                                                             *10*
* 1*  PLEASE ASSIGN "INPUT"          (TO BE USED AS INPUT BY THE PROGRAM)       * 1*
* 2*                                                                             * 2*
* 3*  TO ASSIGN THIS FILE TO A DISK FILE, PLEASE SPECIFY:                        * 3*
* 4*      FILE     =          IN LIBRARY  = UCIDATA* ON VOLUME    = SYS***       * 4*
* 5*                                                                             * 5*
* 6*                                                                             * 6*
* 7*  TO SELECT ANOTHER DEVICE, SPECIFY:                                         * 7*
* 8*      DEVICE   = DISK*******   (ALTERNATES =DISK,NONE)                       * 8*
* 9*                                                                             * 9*
*20*                                                                             *20*
* 1*                                                                             * 1*
* 2*                                                                             * 2*
* 3*                                                                             * 3*
* 4*                                                                             * 4*
*  *                                                                             *  *
**********************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
**********************************************************************************
```

Fig 46. Input to Report

REPORT DATE 10/09/85 ESTIMATING DATA BASE TO BE USED IN CONJUNCTION WITH THE "ESTIMATE" PROGRAM DATA IS BASED ON 1984 PRICES. DATA IS FOR SCHOOL USE ONLY (HOMEWORK, CASE STUDY AND TESTING)! PAGE 1

UCI	CODE	DESCRIPTION	CREWSIZE	UNITS	EQUIPMENT	LABOR	MATERIAL
110	0000000	EQUIPMENT			0.00	0.00	0.00
111	0030001	COOKING RANGE,30" FREESTAND,1 OVEN, MIN		EA	0.00	24.00	320.00
111	0030005	COOKING RANGE,30" FREESTAND,1 OVEN, MAX		EA	0.00	61.00	1200.00
111	0030035	COOKING RANGE,BUILT-IN,30"W,1 OVEN,MIN		EA	0.00	77.00	450.00
111	0030040	COOKING RANGE,BUILT-IN,30"W,1 OVEN,MAX		EA	0.00	155.00	800.00
111	0030090	COUNTER TOP COOK TOPS,4 BURNER,STD,MIN		EA	0.00	29.00	200.00
111	0030095	COUNTER TOP COOK TOPS,4 BURNER,STD,MAX		EA	0.00	59.00	430.00
111	0030125	MICROWAVE OVEN,MIN		EA	0.00	44.00	220.00
111	0030130	MICROWAVE OVEN,MAX		EA	0.00	88.00	1000.00
111	0030175	COMPACTOR,RESIDENTIAL SIZE,4-1 COMP,MIN		EA	0.00	31.00	300.00
111	0030180	COMPACTOR,RESIDENTIAL SIZE,4-1 COMP,MAX		EA	0.00	51.00	440.00
111	0030200	DEEP FREEZE,15-23 CF,MIN		EA	0.00	24.00	420.00
111	0030205	DEEP FREEZE,15-23 CF,MAX		EA	0.00	49.00	620.00
111	0030220	DEEEP FRRREEZE,30 CF, MIN		EA	0.00	31.00	550.00
111	0030225	DEEP FREEZE,30 CF,MAX		EA	0.00	81.00	750.00
111	0030245	DEHUMIDIFIER,PORTABLE,AUTOMATIC,14 PINT		EA	0.00	0.00	175.00
111	0030255	DEHUMIDIFIER,PORTABLE,AUTOMATIC,30 PINT		EA	0 00	0.00	245.00
111	0030275	DISHWASHER,BUILT-IN,2 CYCLE,MIN		EA	0.00	88.00	270.00
111	0030280	DISHWASHER,BUILT-IN,2 CYCLE,MAX		EA	0.00	175.00	360.00
111	0030320	DRYER,AUTOMATIC,MIN		EA	0.00	91.00	260.00
111	0030325	DRYER,AUTOMATIC,MAX		EA	0.00	135.00	530.00
111	0030330	GARBAGE DISPOSER,SINK TYPE,MIN		EA	0.00	71.00	50.00
111	0030335	GARBAGE DISPOSER,SINK TYPE,MAX		EA	0.00	120.00	170.00
111	0030355	HEATER,ELEC,BUILT-IN,1250W,CEILING,MIN		EA	0.00	44.00	40.00

Fig 47. Report Example

Section II: PROJECT DATA FILES

Project Data Files

The project data files are developed through the ESTIMATE program. While the ESTIMATE program is running a description and a quantity project file is created. The following procedures are used to manipulate the project files without running the ESTIMATE program. First, a control file is made for each project file and then an explanation follows on how to add data, modify data and delete data in the project files.

Developing the INDEXDES Project Data File. The following steps are used to develop several procedures used on the description project file.

Project Data Control Set-Up:

1. Logon to the system using standard procedures.

2. The logon menu indicating the PF key for the Utility Menu is now on the monitor. Push the PF key opposite Utility Menu, in this example it's PF key 7 (figure 48).

3. The main Utility Menu is now on the monitor. In order to create a data base file a control file must first be created to define how the data will be stored in the file. Push the PF key opposite Control, in this example it's PF key 1 (figure 49).

4. The next screen (figure 50) prompts for the name of the control file. Type in INDEXDES as shown in figure 51 and press "enter".

5. The next screen is the Control File Menu (figure 52). To create a control file press PF key 2.

6. The next screen now indicates creation of file header information (figure 53). Type in the items shown in figure 54 and press "enter".

7. The creation of field specifications is now on the

monitor (figure 55). Each field in the data base must have a specification. A total of eleven fields are used in the data base. Type in the items shown in Figures 56 thru 66 for each field. After completing a specification press "enter". In some cases the screen showing Field Input Validation Specifications may appear (figure 67). Do nothing to this screen, press "enter" and the field specification screen will reappear.

8. After entering the last field press PF key 16 to return to the Control File Menu. A control file now exists called INDEXDES. Continue pressing PF key 16 until the main Utility Menu is reached.

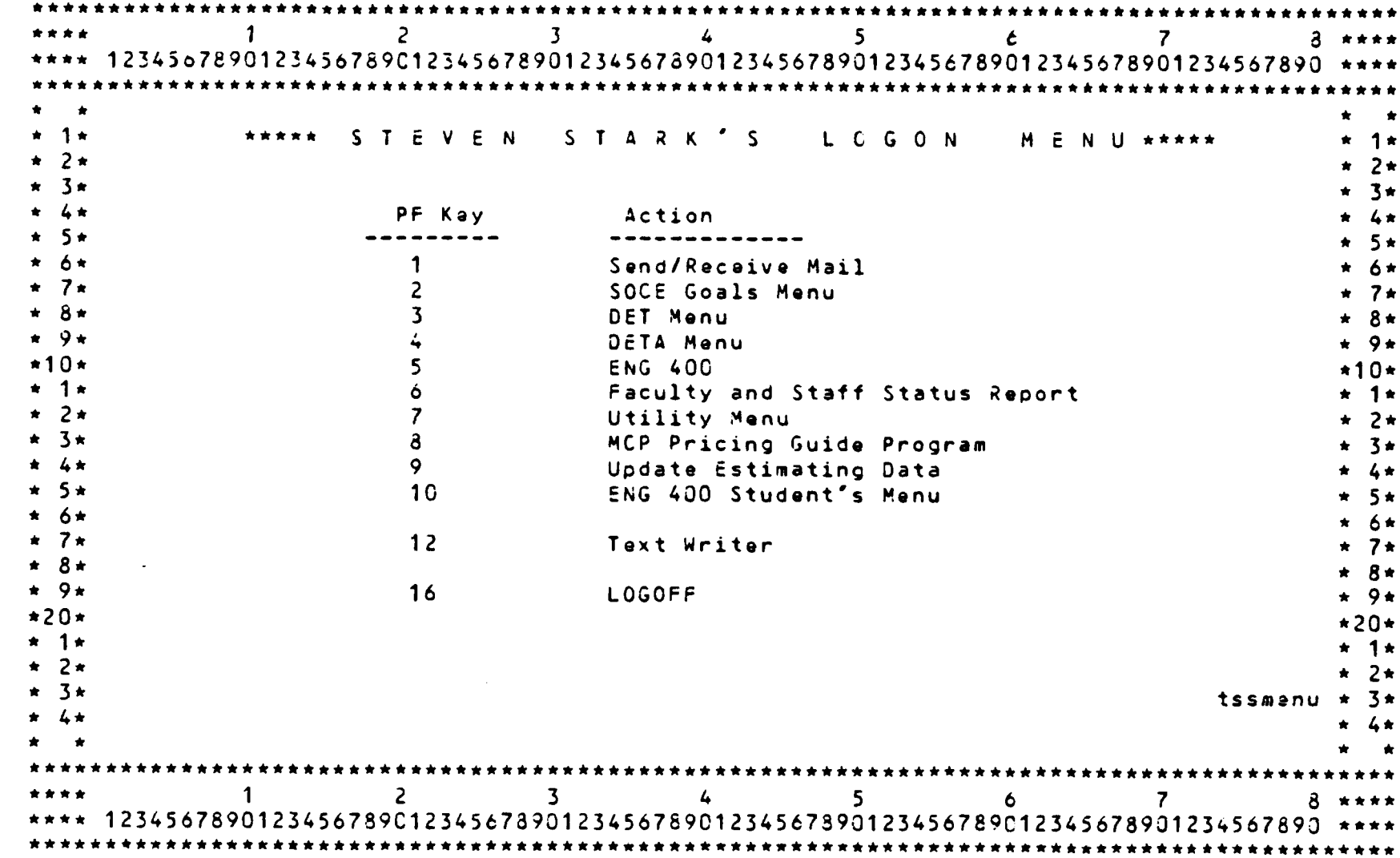


Fig 48. Logon Menu

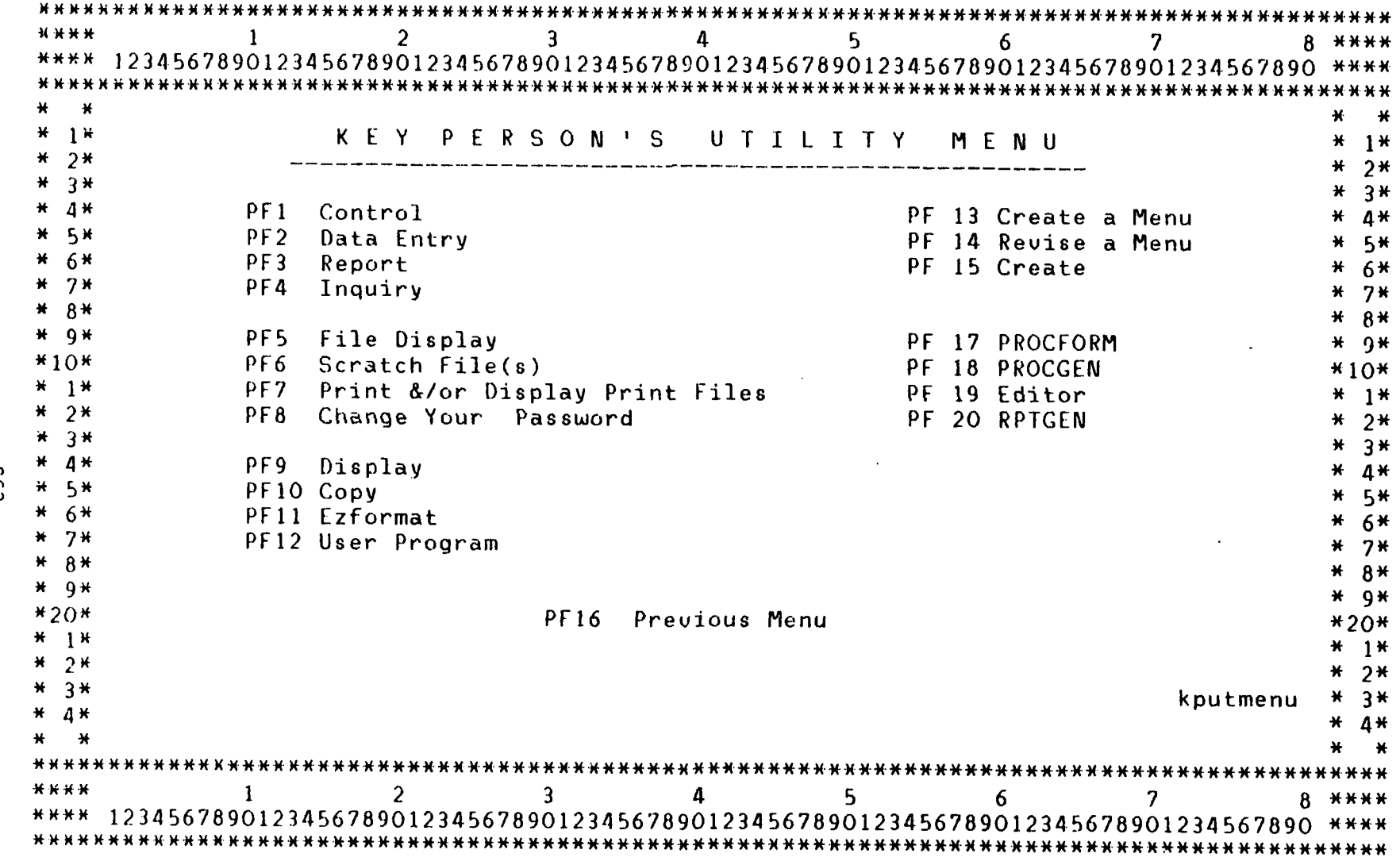


Fig 49. Utility Menu

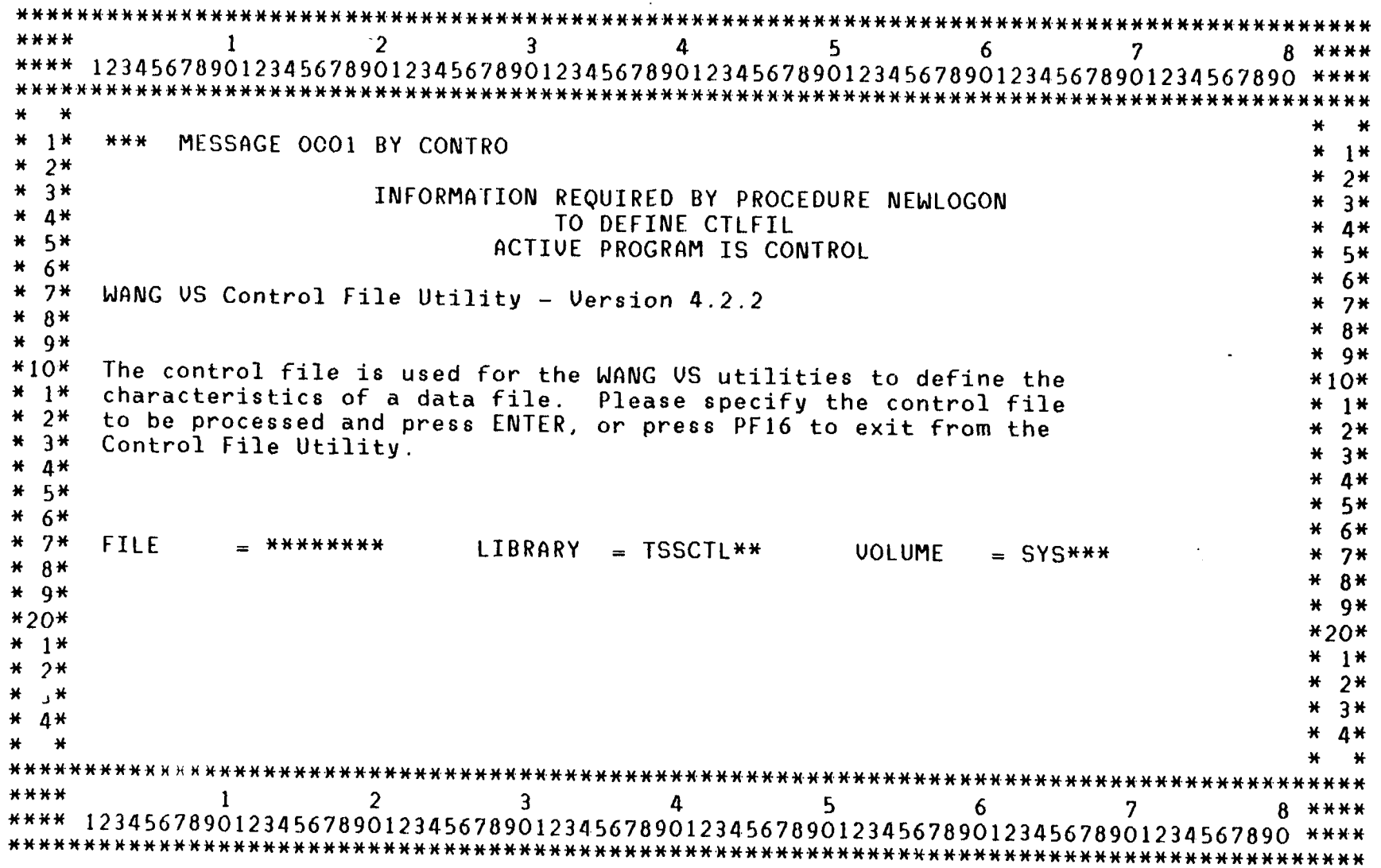


Fig 50. Control File Utility

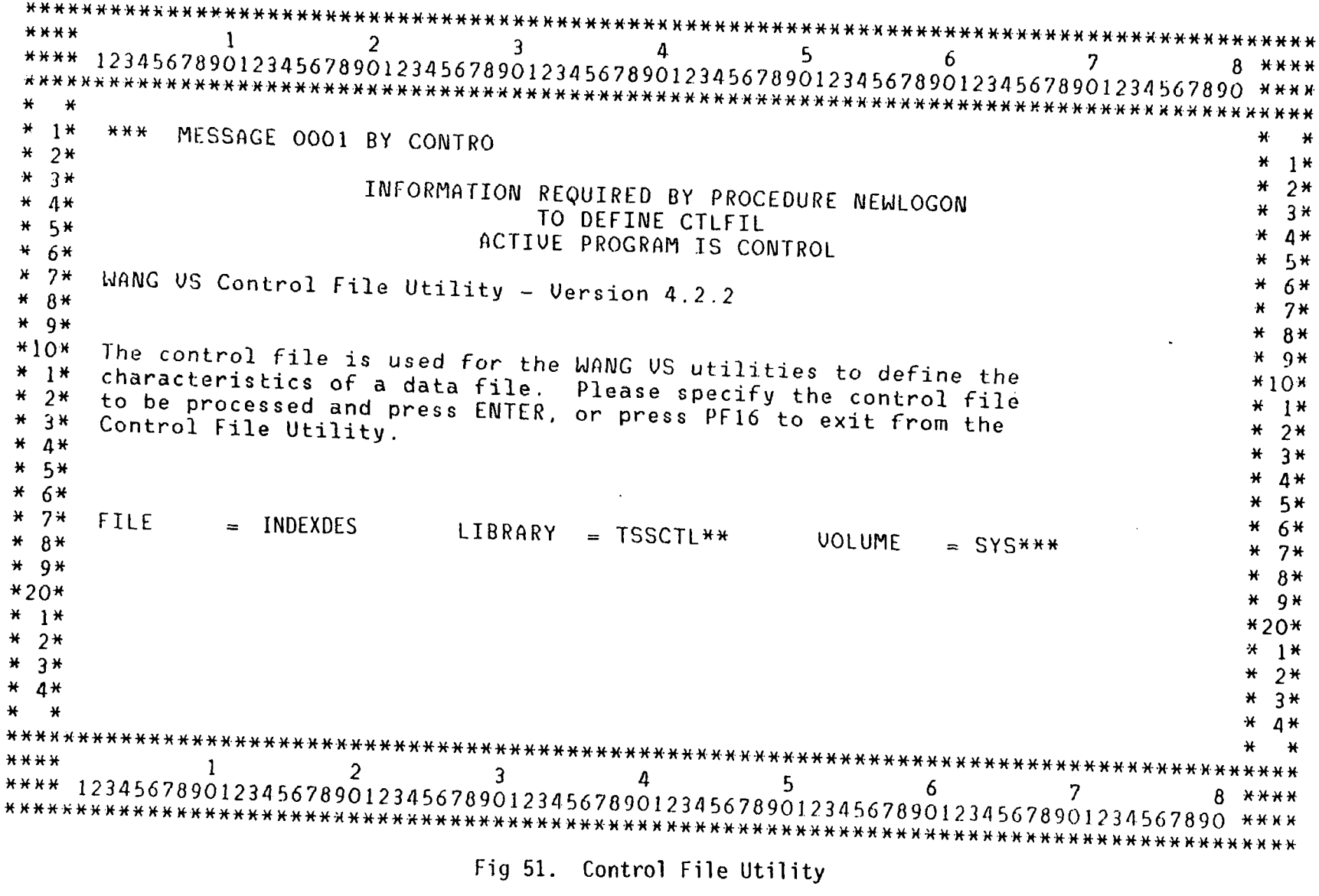


Fig 51. Control File Utility

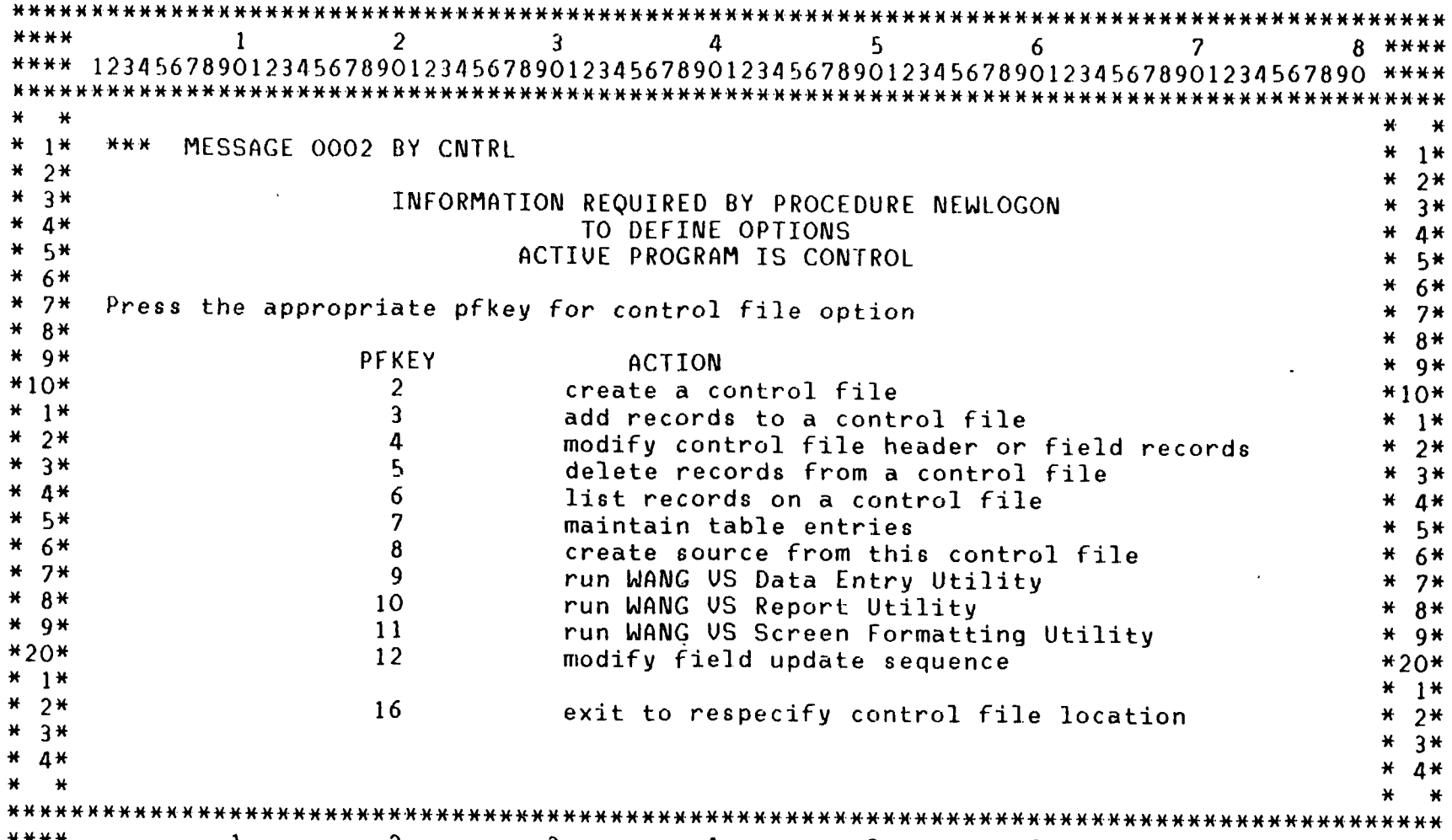


Fig 52. Control File Menu

```
*****************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
*****************************************************************************
*  *                                                                        *  *
* 1*  ***  MESSAGE COO1 BY CONTRO                                          * 1*
* 2*                                                                       * 2*
* 3*                    INFORMATION REQUIRED BY PROCEDURE NEWLOGON          * 3*
* 4*                                  TO DEFINE HEADER                     * 4*
* 5*                               ACTIVE PROGRAM IS CONTROL               * 5*
* 6*                                                                       * 6*
* 7*  Creation of file header information.  Enter parameters for the data file. * 7*
* 8*                                                                       * 8*
* 9*                                                                       * 9*
*10*  RECLEN    = ****          (1-2040 fixed; 1-2020 var; 1-2024 compress length)  *10*
* 1*  KEYFIELD  = ********      (assume consecutive file if not specified)          * 1*
* 2*  ALTKEYS   = 00            (1-16,number of alternate keys to indexed file)     * 2*
* 3*  USEREXIT  = ********      (user supplied, if any: "USER1" -- "USER10")        * 3*
* 4*  REPORT    = 0             (0-report allowed, 1-not allowed)                   * 4*
* 5*  UPDATE    = 0             (0-record update allowed, 1-not allowed)            * 5*
* 6*  DELETE    = 0             (0-record deletions allowed, 1-not allowed)         * 6*
* 7*  FILETYPE  = F             (F-fixed, V-variable, C-compressed records)         * 7*
* 8*  COMMENT1  = ************************************************************      * 8*
* 9*  COMMENT2  = ************************************************************      * 9*
*20*  COMMENT3  = ************************************************************      *20*
* 1*                  ***any comments to be included in file***(optional)          * 1*
* 2*                                                                               * 2*
* 3*                  Press PF16 to return to Control File Utility menu            * 3*
* 4*                                                                               * 4*
*  *                                                                               *  *
*****************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
*****************************************************************************
```

Fig 53. File Header

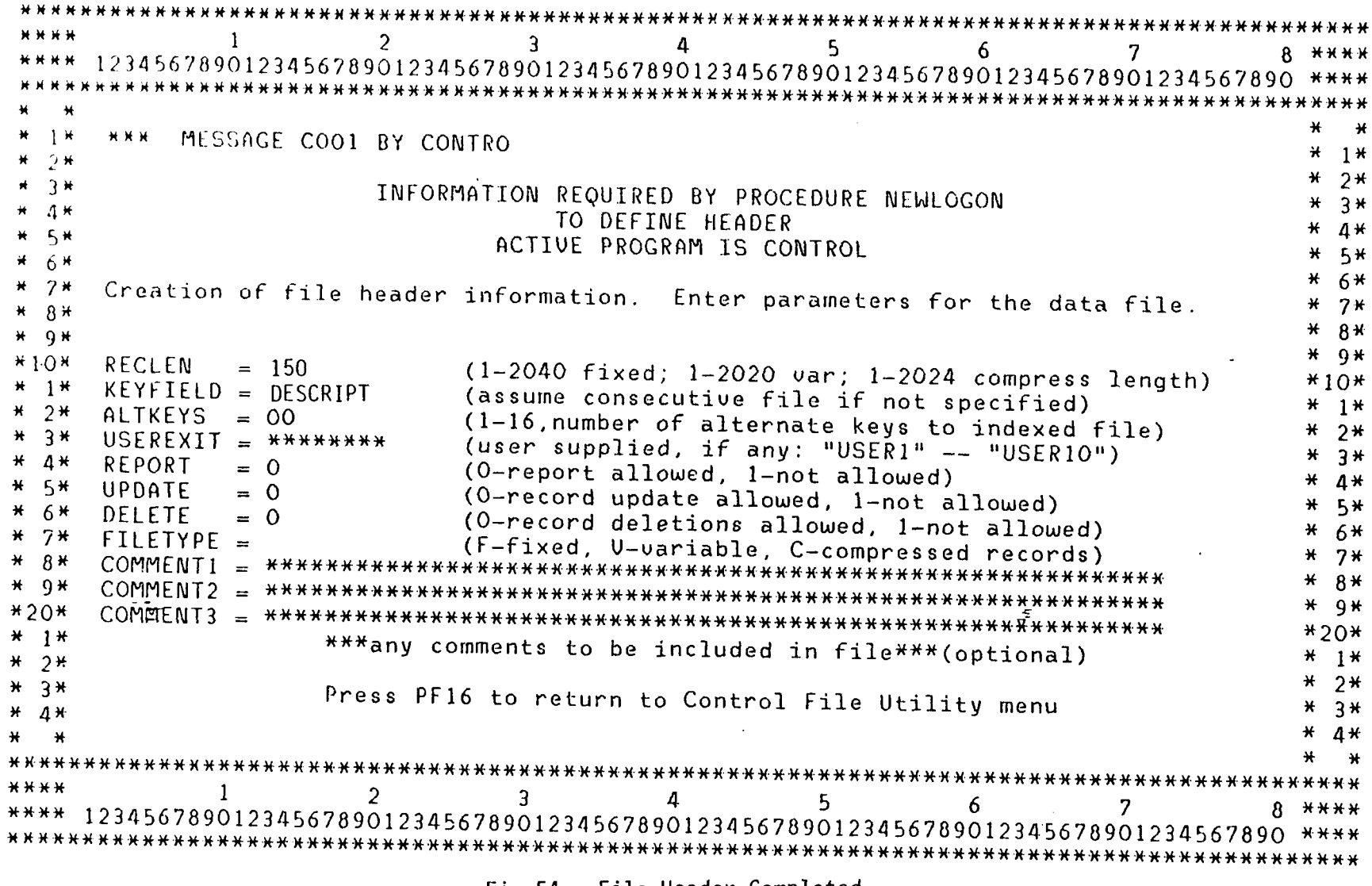


Fig 54. File Header Completed

Fig 55. Field Specification

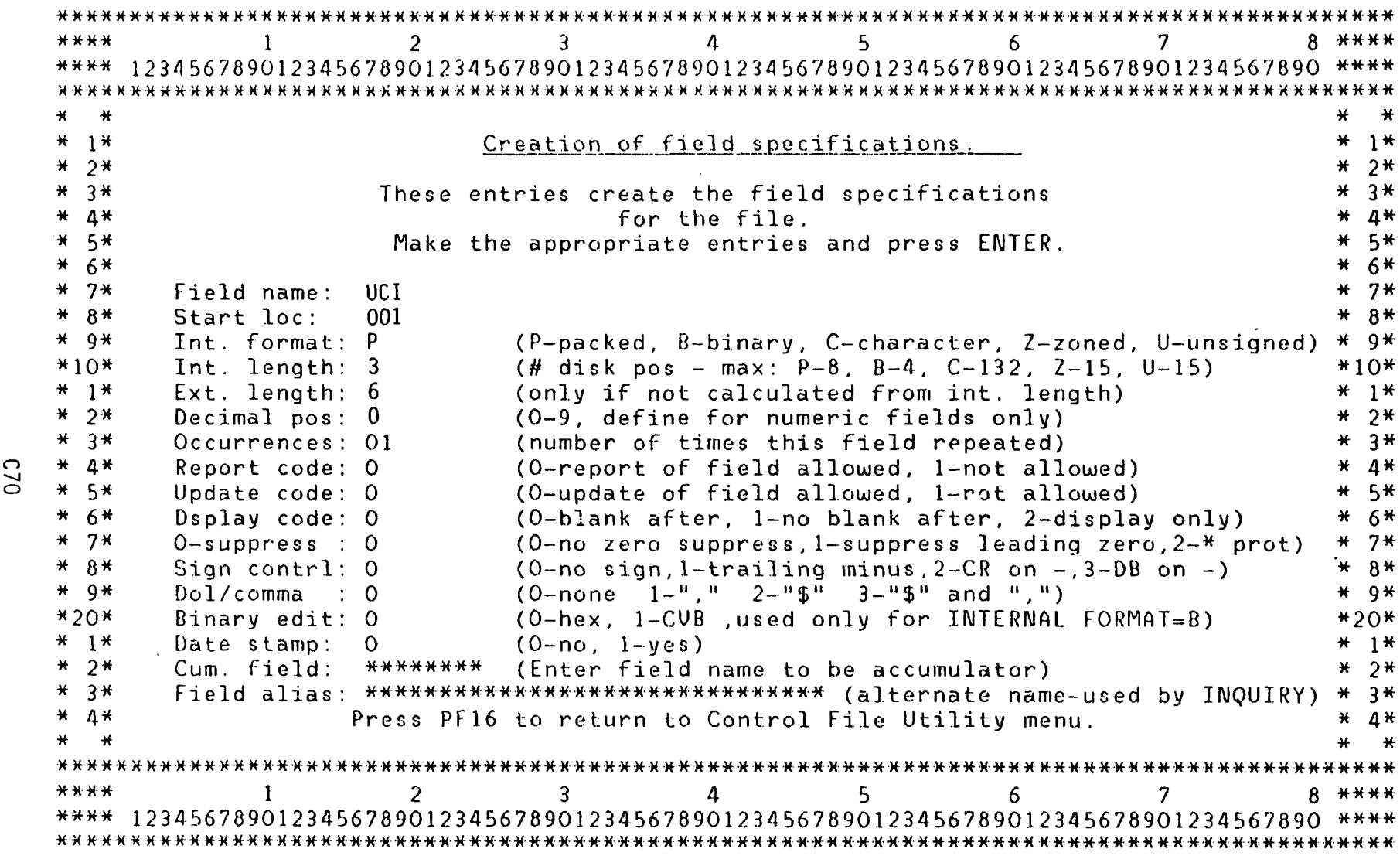


Fig 56. Field Specification for UCI

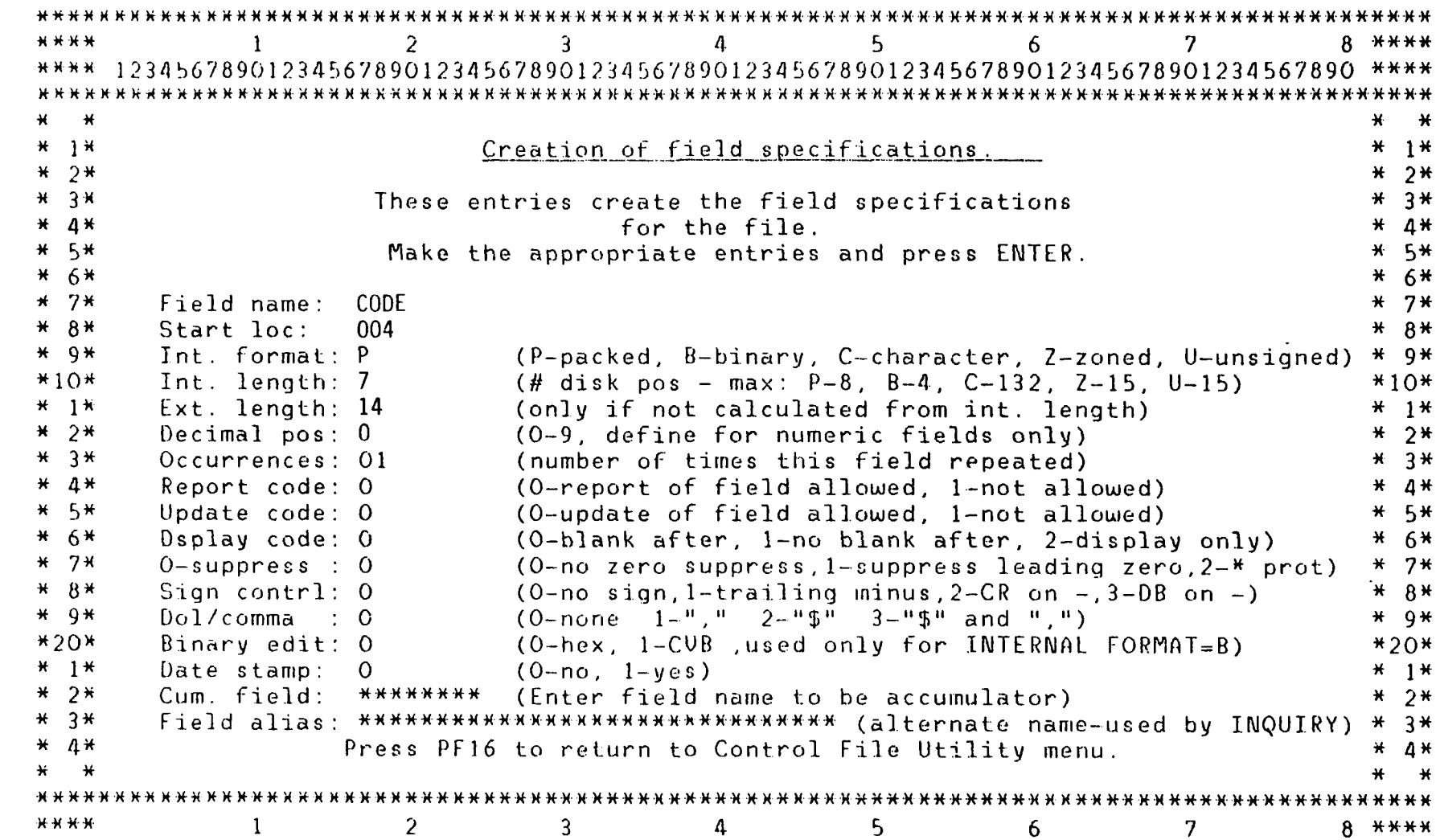


Fig 57. Field Specification for CODE

```
**********************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
**********************************************************************************
*  *                                                                             *  *
* 1*                        Creation of field specifications.                    * 1*
* 2*                                                                             * 2*
* 3*                   These entries create the field specifications             * 3*
* 4*                                  for the file.                              * 4*
* 5*                    Make the appropriate entries and press ENTER.            * 5*
* 6*                                                                             * 6*
* 7*     Field name:  DESCRIPT                                                   * 7*
* 8*     Start loc:   011                                                        * 8*
* 9*     Int. format: C          (P-packed, B-binary, C-character, Z-zoned, U-unsigned) * 9*
*10*     Int. length: 40         (# disk pos - max: P-8, B-4, C-132, Z-15, U-15)  *10*
* 1*     Ext. length: 40         (only if not calculated from int. length)       * 1*
* 2*     Decimal pos: 0          (0-9, define for numeric fields only)           * 2*
* 3*     Occurrences: 01         (number of times this field repeated)           * 3*
* 4*     Report code: 0          (0-report of field allowed, 1-not allowed)      * 4*
* 5*     Update code: 0          (0-update of field allowed, 1-not allowed)      * 5*
* 6*     Dsplay code: 0          (0-blank after, 1-no blank after, 2-display only) * 6*
* 7*     0-suppress : 0          (0-no zero suppress,1-suppress leading zero,2-* prot) * 7*
* 8*     Sign contrl: 0          (0-no sign,1-trailing minus,2-CR on -,3-DB on -) * 8*
* 9*     Dol/comma  : 0          (0-none  1-","  2-"$"  3-"$" and ",")           * 9*
*20*     Binary edit: 0          (0-hex, 1-CVB ,used only for INTERNAL FORMAT=B)  *20*
* 1*     Date stamp:  0          (0-no, 1-yes)                                   * 1*
* 2*     Cum. field:  ********   (Enter field name to be accumulator)            * 2*
* 3*     Field alias: ********************************* (alternate name-used by INQUIRY) * 3*
* 4*                  Press PF16 to return to Control File Utility menu.         * 4*
*  *                                                                             *  *
**********************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
**********************************************************************************
```

Fig 58. Field Specification for DESCRIPT

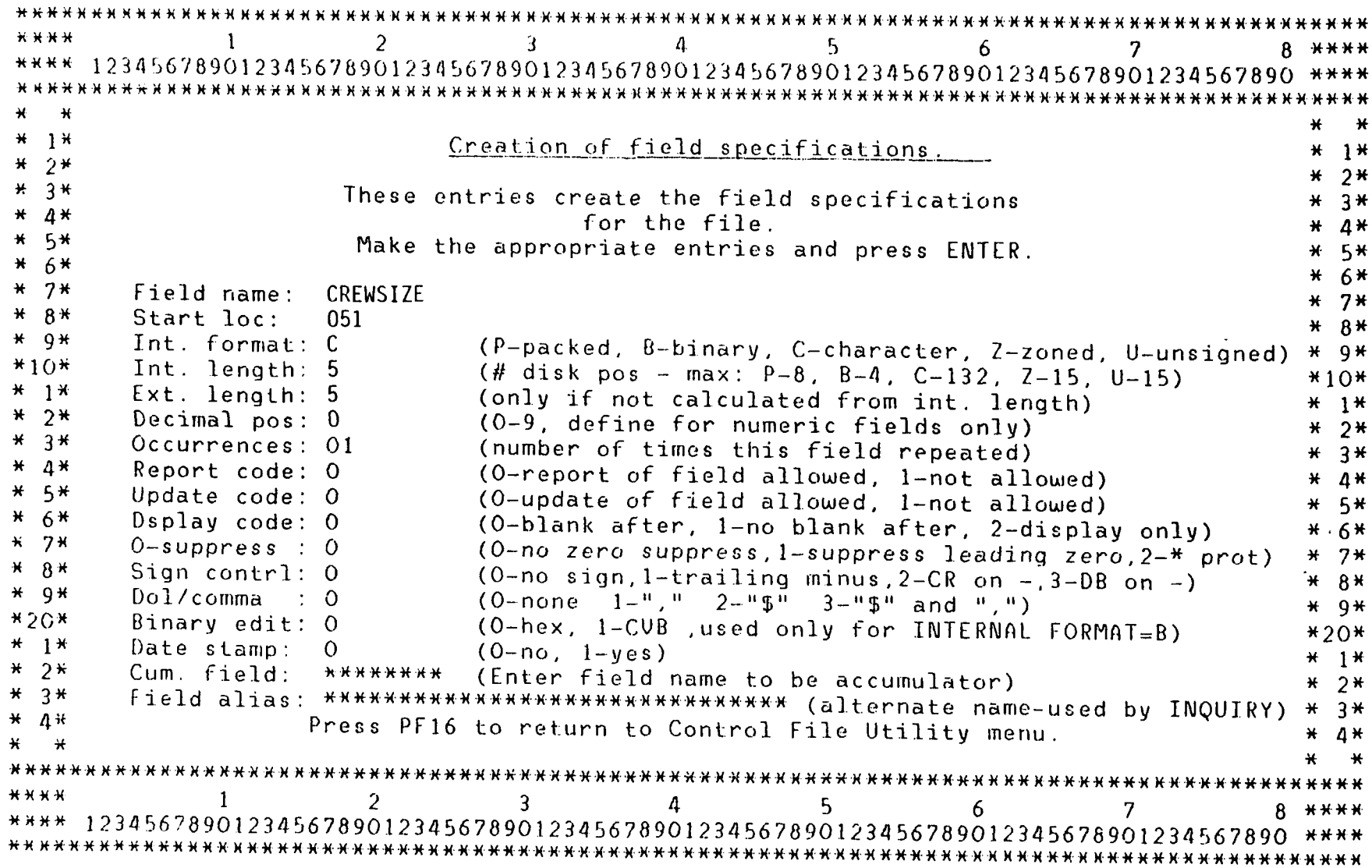


Fig 59. Field Specification for CREWSIZE

```
*****************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
*****************************************************************************
*  *                                                                        *  *
* 1*                      Creation of field specifications.                 * 1*
* 2*                                                                        * 2*
* 3*                  These entries create the field specifications         * 3*
* 4*                                  for the file.                         * 4*
* 5*                   Make the appropriate entries and press ENTER.        * 5*
* 6*                                                                        * 6*
* 7*    Field name:  OUTPUT                                                 * 7*
* 8*    Start loc:   056                                                    * 8*
* 9*    Int. format: P          (P-packed, B-binary, C-character, Z-zoned, U-unsigned) * 9*
*10*    Int. length: 5          (# disk pos - max: P-8, B-4, C-132, Z-15, U-15)  *10*
* 1*    Ext. length: 10         (only if not calculated from int. length)       * 1*
* 2*    Decimal pos: 0          (0-9, define for numeric fields only)           * 2*
* 3*    Occurrences: 01         (number of times this field repeated)           * 3*
* 4*    Report code: 0          (0-report of field allowed, 1-not allowed)      * 4*
* 5*    Update code: 0          (0-update of field allowed, 1-not allowed)      * 5*
* 6*    Dsplay code: 0          (0-blank after, 1-no blank after, 2-display only) * 6*
* 7*    0-suppress : 0          (0-no zero suppress,1-suppress leading zero,2-* prot) * 7*
* 8*    Sign contrl: 0          (0-no sign,1-trailing minus,2-CR on -,3-DB on -) * 8*
* 9*    Dol/comma  : 0          (0-none  1-","  2-"$"  3-"$" and ",")           * 9*
*20*    Binary edit: 0          (0-hex, 1-CUB ,used only for INTERNAL FORMAT=B)  *20*
* 1*    Date stamp:  0          (0-no, 1-yes)                                   * 1*
* 2*    Cum. field:  ********   (Enter field name to be accumulator)           * 2*
* 3*    Field alias: ********************************* (alternate name-used by INQUIRY) * 3*
* 4*                 Press PF16 to return to Control File Utility menu.       * 4*
*  *                                                                        *  *
*****************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
*****************************************************************************
```

Fig 60. Field Specification for OUTPUT

Fig 61. Field Specification for UNITS

```
********************************************************************************
****          1         2         3         4         5         6         7    8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
********************************************************************************
*  *                                                                           *  *
* 1*                        Creation of field specifications.                  * 1*
* 2*                                                                           * 2*
* 3*                   These entries create the field specifications           * 3*
* 4*                                  for the file.                            * 4*
* 5*                    Make the appropriate entries and press ENTER.          * 5*
* 6*                                                                           * 6*
* 7*     Field name:  EQUIP                                                    * 7*
* 8*     Start loc:   066                                                      * 8*
* 9*     Int. format: P          (P-packed, B-binary, C-character, Z-zoned, U-unsigned) * 9*
*10*     Int. length: 6          (# disk pos - max: P-8, B-4, C-132, Z-15, U-15)       *10*
* 1*     Ext. length: 10         (only if not calculated from int. length)            * 1*
* 2*     Decimal pos: 2          (0-9, define for numeric fields only)                * 2*
* 3*     Occurrences: 01         (number of times this field repeated)                * 3*
* 4*     Report code: 0          (0-report of field allowed, 1-not allowed)           * 4*
* 5*     Update code: 0          (0-update of field allowed, 1-not allowed)           * 5*
* 6*     Dsplay code: 0          (0-blank after, 1-no blank after, 2-display only)    * 6*
* 7*     0-suppress : 0          (0-no zero suppress,1-suppress leading zero,2-* prot) * 7*
* 8*     Sign contrl: 0          (0-no sign,1-trailing minus,2-CR on -,3-DB on -)      * 8*
* 9*     Dol/comma  : 0          (0-none  1-","  2-"$"  3-"$" and ",")                * 9*
*20*     Binary edit: 0          (0-hex, 1-CVB ,used only for INTERNAL FORMAT=B)       *20*
* 1*     Date stamp:  0          (0-no, 1-yes)                                        * 1*
* 2*     Cum. field:  ********   (Enter field name to be accumulator)                 * 2*
* 3*     Field alias: ********************************* (alternate name-used by INQUIRY) * 3*
* 4*                  Press PF16 to return to Control File Utility menu.           * 4*
*  *                                                                           *  *
********************************************************************************
****          1         2         3         4         5         6         7    8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
********************************************************************************
```

Fig 62. Field Specification for EQUIP

```
**********************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
**********************************************************************************
*  *                                                                             *  *
* 1*                        Creation of field specifications.                    * 1*
* 2*                                                                             * 2*
* 3*                  These entries create the field specifications              * 3*
* 4*                                    for the file.                            * 4*
* 5*                   Make the appropriate entries and press ENTER.             * 5*
* 6*                                                                             * 6*
* 7*    Field name:  MATERIAL                                                    * 7*
* 8*    Start loc:   072                                                         * 8*
* 9*    Int. format: P          (P-packed, B-binary, C-character, Z-zoned, U-unsigned) * 9*
*10*    Int. length: 6          (# disk pos - max: P-8, B-4, C-132, Z-15, U-15)   *10*
* 1*    Ext. length: 10         (only if not calculated from int. length)        * 1*
* 2*    Decimal pos: 2          (0-9, define for numeric fields only)            * 2*
* 3*    Occurrences: 01         (number of times this field repeated)            * 3*
* 4*    Report code: 0          (0-report of field allowed, 1-not allowed)       * 4*
* 5*    Update code: 0          (0-update of field allowed, 1-not allowed)       * 5*
* 6*    Dsplay code: 0          (0-blank after, 1-no blank after, 2-display only) * 6*
* 7*    0-suppress : 0          (0-no zero suppress,1-suppress leading zero,2-* prot) * 7*
* 8*    Sign contrl: 0          (0-no sign,1-trailing minus,2-CR on -,3-DB on -) * 8*
* 9*    Dol/comma  : 0          (0-none  1-","  2-"$"  3-"$" and ",")            * 9*
*20*    Binary edit: 0          (0-hex, 1-CUB ,used only for INTERNAL FORMAT=B)   *20*
* 1*    Date stamp:  0          (0-no, 1-yes)                                    * 1*
* 2*    Cum. field:  ********   (Enter field name to be accumulator)             * 2*
* 3*    Field alias: ********************************* (alternate name-used by INQUIRY) * 3*
* 4*                  Press PF16 to return to Control File Utility menu.         * 4*
*  *                                                                             *  *
**********************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
**********************************************************************************
```

Fig 63. Field Specification for MATERIAL

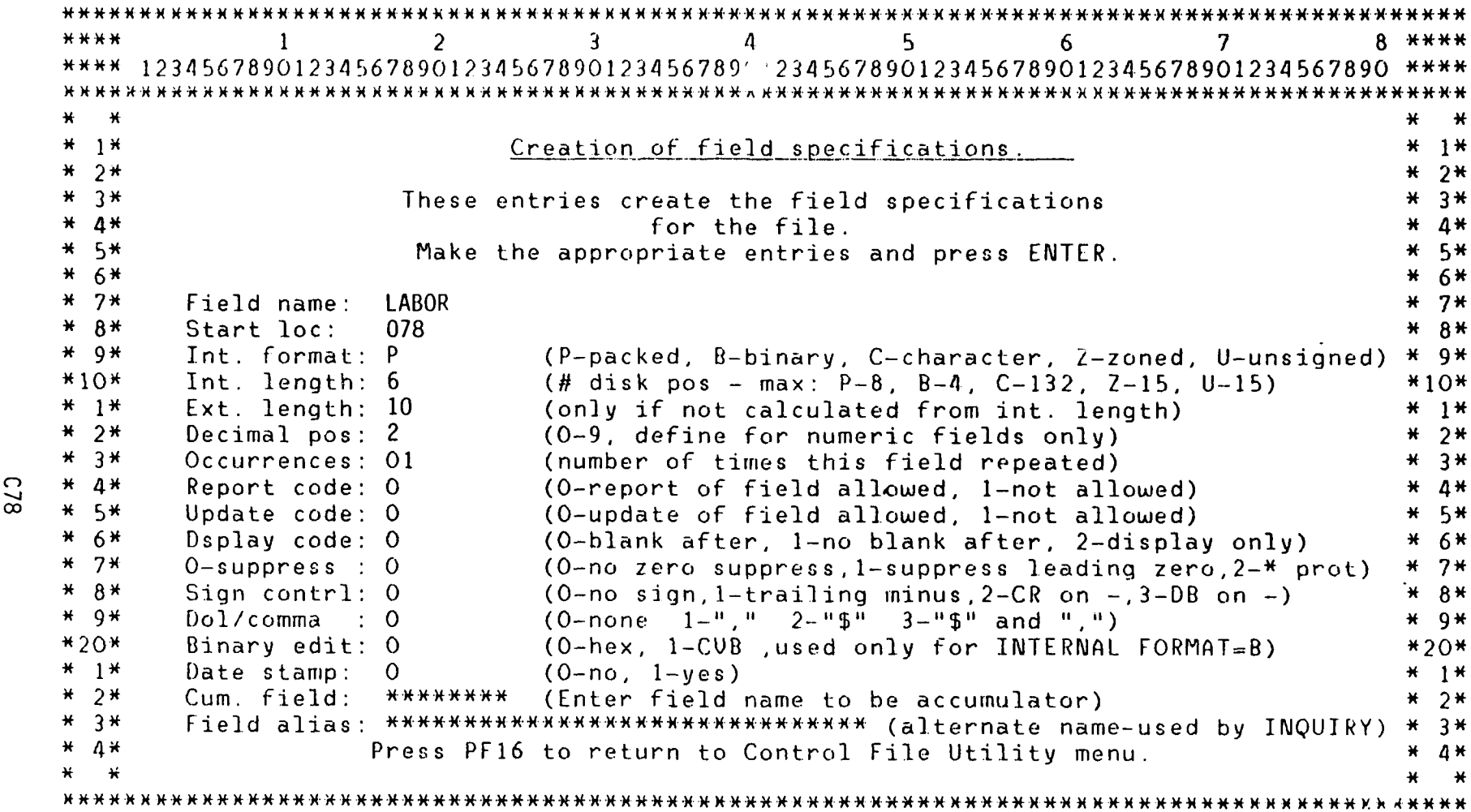


Fig 64. Field Specification for LABOR

Fig 65. Field Specification for BARECOST

```
C80
**********************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
**********************************************************************************
*  *                                                                             *  *
* 1*                        Creation of field specifications.                    * 1*
* 2*                                                                             * 2*
* 3*                    These entries create the field specifications            * 3*
* 4*                                    for the file.                            * 4*
* 5*                     Make the appropriate entries and press ENTER.           * 5*
* 6*                                                                             * 6*
* 7*     Field name:  TOTO&P                                                     * 7*
* 8*     Start loc:   090                                                        * 8*
* 9*     Int. format: P          (P-packed, B-binary, C-character, Z-zoned, U-unsigned) * 9*
*10*     Int. length: 6          (# disk pos - max: P-8, B-4, C-132, Z-15, U-15)  *10*
* 1*     Ext. length: 10         (only if not calculated from int. length)       * 1*
* 2*     Decimal pos: 2          (0-9, define for numeric fields only)           * 2*
* 3*     Occurrences: 01         (number of times this field repeated)           * 3*
* 4*     Report code: 0          (0-report of field allowed, 1-not allowed)      * 4*
* 5*     Update code: 0          (0-update of field allowed, 1-not allowed)      * 5*
* 6*     Dsplay code: 0          (0-blank after, 1-no blank after, 2-display only) * 6*
* 7*     0-suppress : 0          (0-no zero suppress,1-suppress leading zero,2-* prot) * 7*
* 8*     Sign contrl: 0          (0-no sign,1-trailing minus,2-CR on -,3-DB on -) * 8*
* 9*     Dol/comma  : 0          (0-none  1-","  2-"$"  3-"$" and ",")           * 9*
*20*     Binary edit: 0          (0-hex, 1-CVB ,used only for INTERNAL FORMAT=B)  *20*
* 1*     Date stamp:  0          (0-no, 1-yes)                                   * 1*
* 2*     Cum. field:  ********   (Enter field name to be accumulator)            * 2*
* 3*     Field alias: ********************************* (alternate name-used by INQUIRY) * 3*
* 4*                  Press PF16 to return to Control,File Utility menu.         * 4*
*  *                                                                             *  *
**********************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
**********************************************************************************
```

Fig 66. Field Specification for TOTO&P

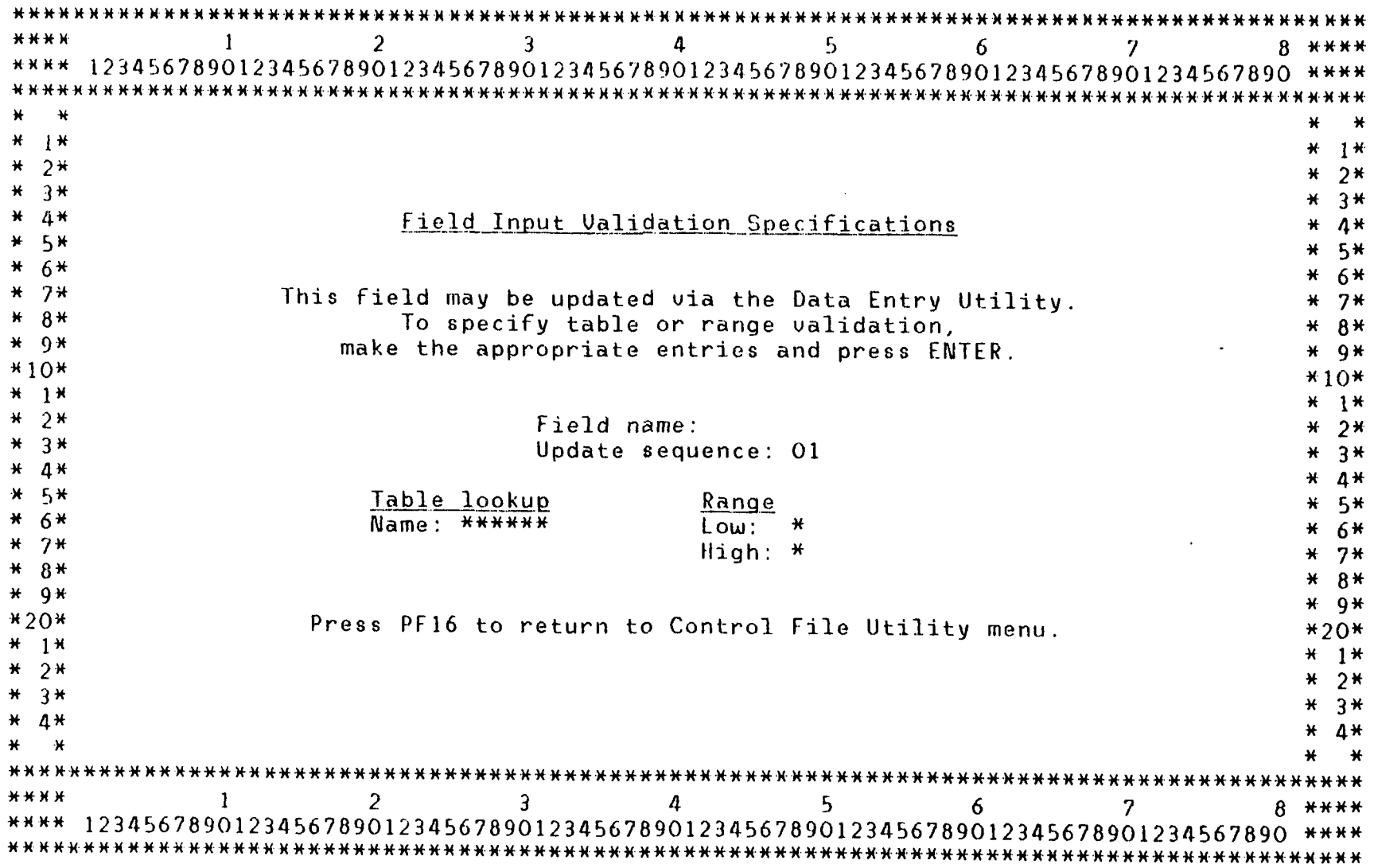


Fig 67. Field Input Validation

Modifications to the Description Project Data File:

1. Press the PF key opposite Data Entry, in this example it's PF key 2 (figure 68).

2. The computer now prompts for the data file and the control file as shown in figure 69. Type in the items shown in figure 70 and press "enter".

3. The data entry menu is now on the monitor (figure 71). To modify a record in the file press PF key 3.

4. The next screen (figure 72) must now be completed. The description is exactly the same as when the item was originally entered into the data file.

5. The next screen displays the record to be modified (figure 73). All the items can now be changed except the DESCRIPT field. After changes are made press "enter" to modify the file. If "enter" is not pressed the changes are not made.

6. Press PF key 16 to exit.

Deletion of Files From the Description Project Data File:

1. Repeat steps 1 and 2 under modifications to the data base.

2. Press PF key 5 as shown in figure 71 to delete records from a data file.

3. The next screen (figure 74) is very similar to the screen used to make modifications. Type in the DESCRIPT for the record to be deleted and press "enter". If the DESCRIPT can be found in the data the record will be deleted, if not, a message will appear on the screen indicating "record could not be found".

4. Press PF key 16 to exit.

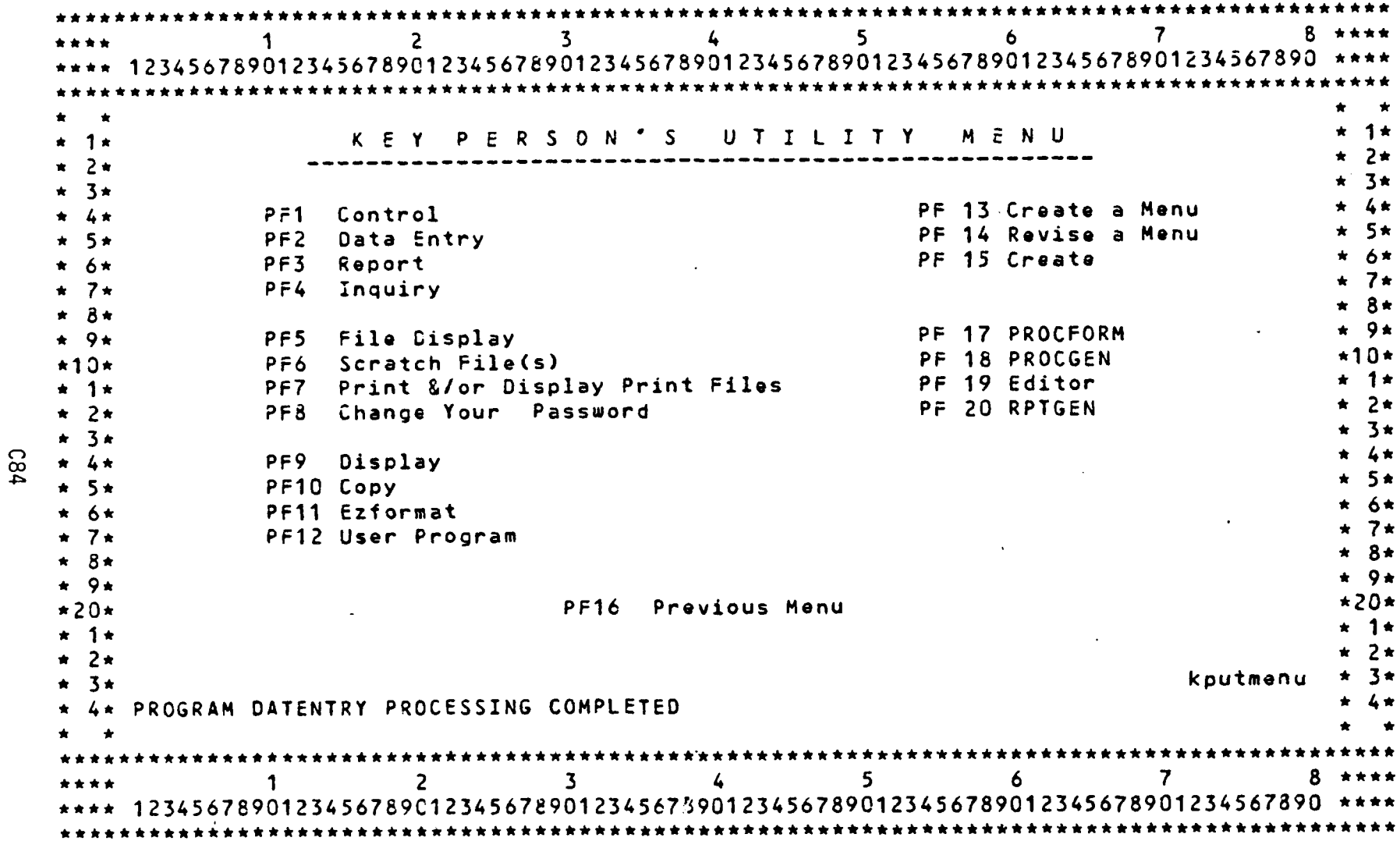


Fig 68. Utility Menu

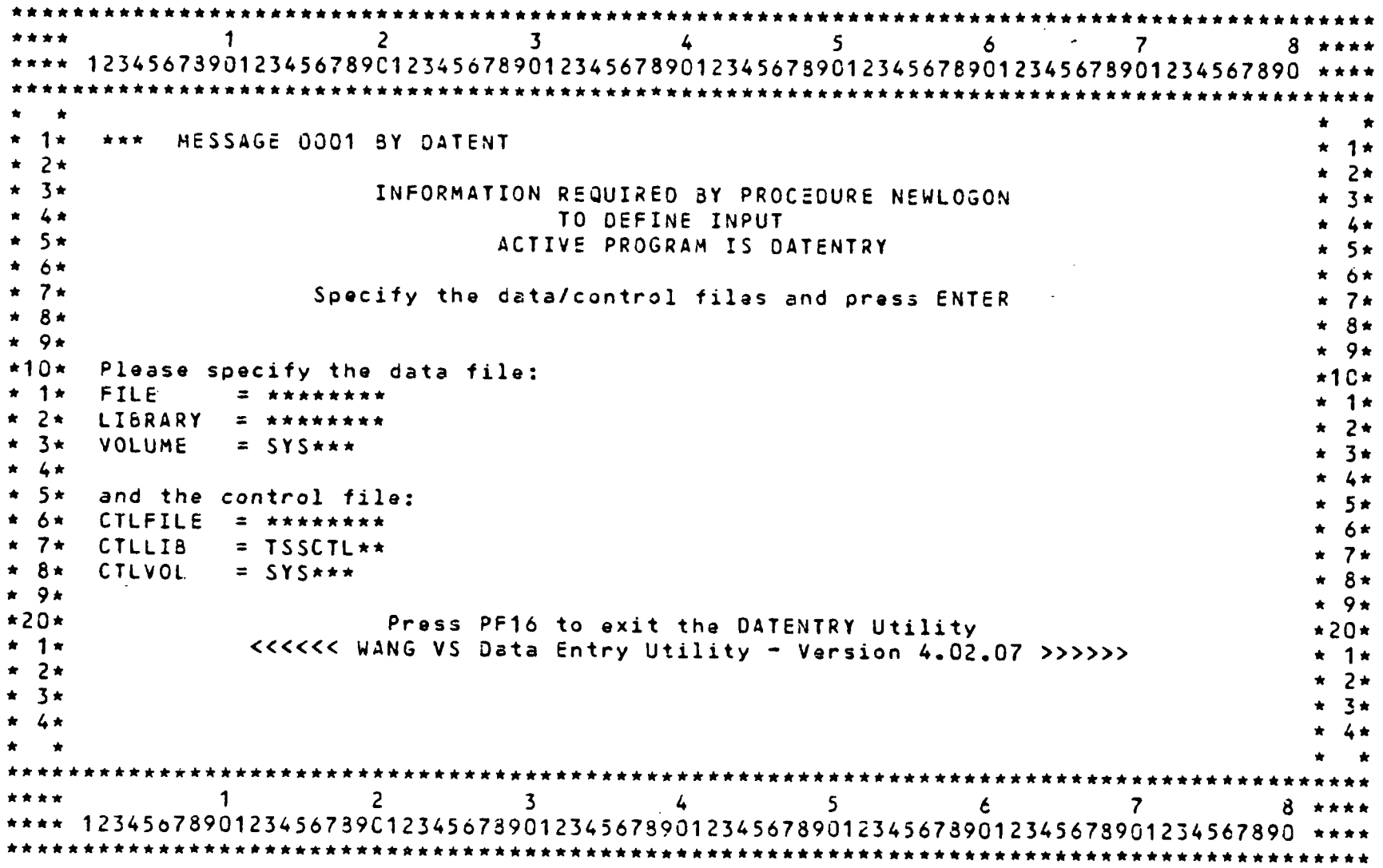


Fig 69. Data Entry Information

```
****************************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
****************************************************************************************
*  *                                                                                   *  *
* 1*  ***  MESSAGE 0001 BY DATENT                                                     * 1*
* 2*                                                                                   * 2*
* 3*                      INFORMATION REQUIRED BY PROCEDURE NEWLOGON                   * 3*
* 4*                                  TO DEFINE INPUT                                  * 4*
* 5*                            ACTIVE PROGRAM IS DATENTRY                             * 5*
* 6*                                                                                   * 6*
* 7*                 Specify the data/control files and press ENTER                    * 7*
* 8*                                                                                   * 8*
* 9*                                                                                   * 9*
*10*  Please specify the data file:                                                    *10*
* 1*  FILE     =  (name of project descript file created during ESTIMATE program)     * 1*
* 2*  LIBRARY  =  (location of project descript file)                                  * 2*
* 3*  VOLUME   = SYS***                                                               * 3*
* 4*                                                                                   * 4*
* 5*  and the control file:                                                          * 5*
* 6*  CTLFILE  = INDEXDES                                                            * 6*
* 7*  CTLLIB   = TSSCTL**                                                            * 7*
* 8*  CTLVOL   = SYS***                                                              * 8*
* 9*                                                                                   * 9*
*20*                    Press PF16 to exit the DATENTRY Utility                       *20*
* 1*             <<<<<< WANG VS Data Entry Utility - Version 4.02.07 >>>>>>           * 1*
* 2*                                                                                   * 2*
* 3*                                                                                   * 3*
* 4*                                                                                   * 4*
*  *                                                                                   *  *
****************************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
****************************************************************************************
```

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Fig 70. Example Data Entry

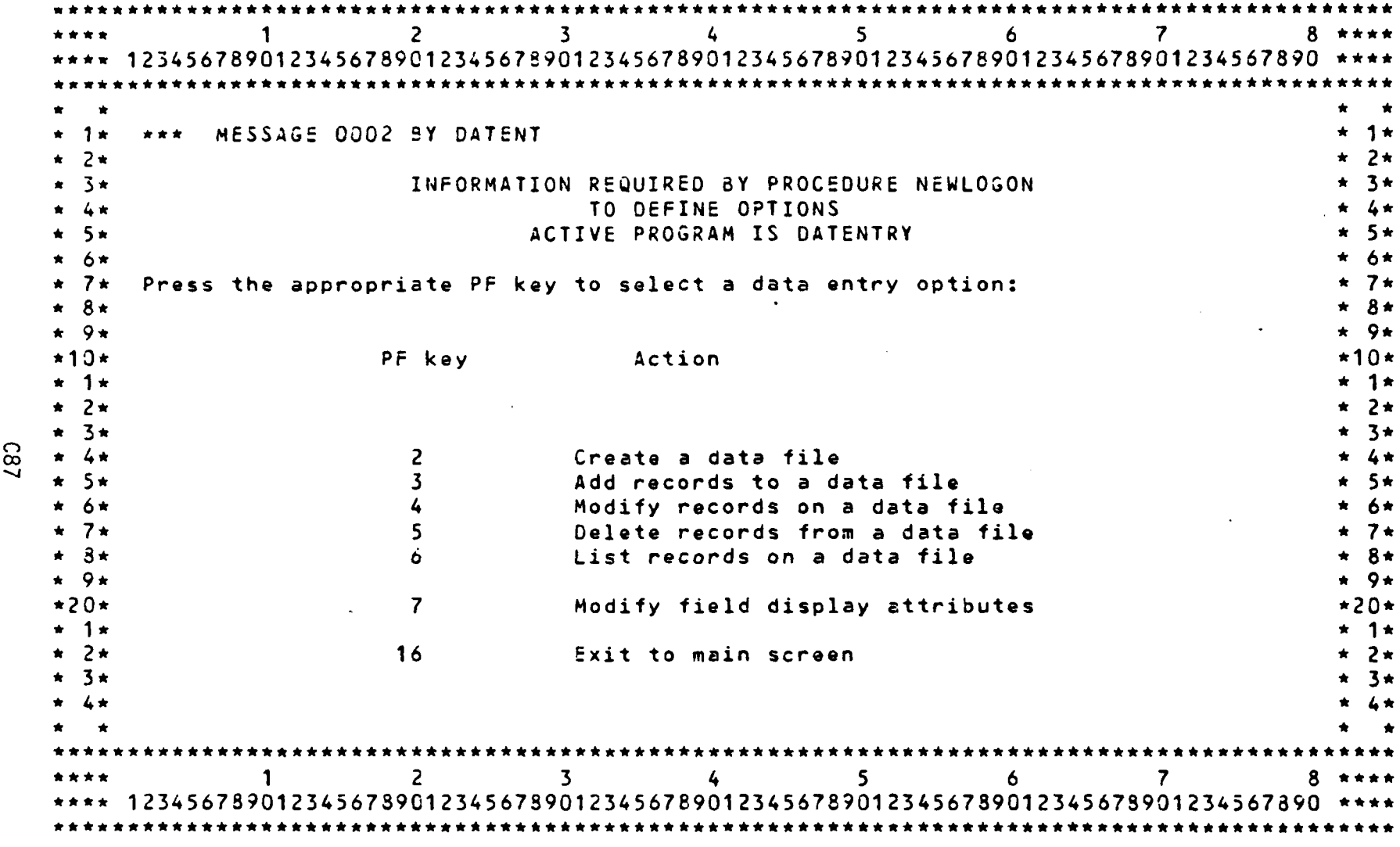

Fig 71. Data Entry Menu

Fig 72. Modifications to Existing Project Data

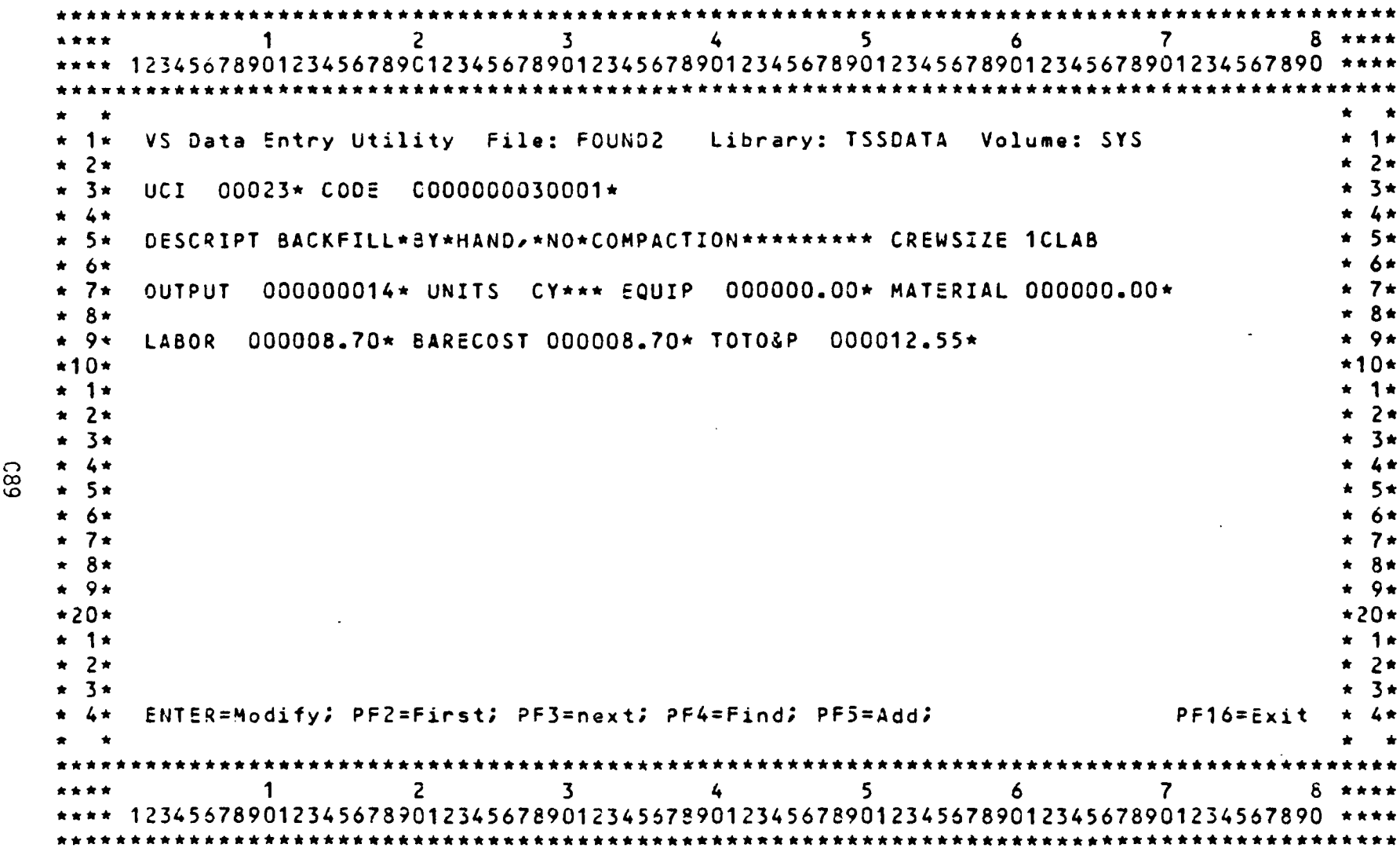

Fig 73. Example to be Modified

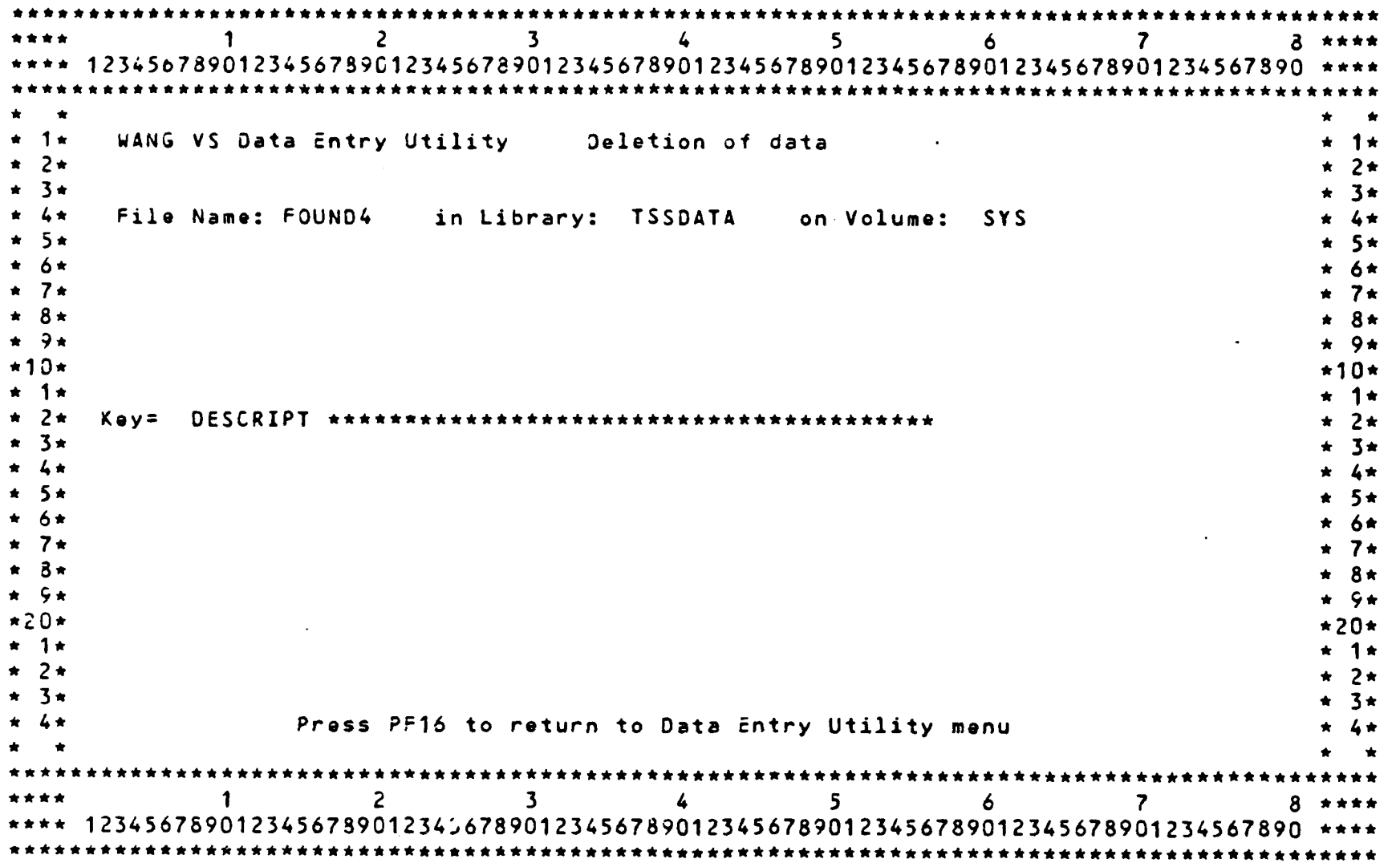

Fig 74. Deletions to Existing Project Data

Developing the INDEXQNT Project Data File. The following steps are used to develop several procedures used on the quantity project file.

Project Data Control Set-Up:

1. Logon to the system using standard procedures.

2. The logon menu indicating the PF key for the Utility Menu is now on the monitor. Push the PF key opposite Utility Menu, in this example it's PF key 7 (figure 75).

3. The main Utility Menu is now on the monitor. In order to create a data base file a control file must first be created to define how the data will be stored in the file. Push the PF key opposite Control, in this example it's PF key 1 (figure 76).

4. The next screen (figure 77) prompts for the name of the control file. Type in INDEXQNT as shown in figure 78 and press "enter".

5. The next screen is the Control File Menu (figure 79). To create a control file press PF key 2.

6. The next screen now indicates creation of file header information (figure 80). Type in the items shown in figure 81 and press "enter".

7. The creation of field specifications is now on the monitor (figure 82). Each field in the data base must have a specification. A total of eleven fields are used in the data base. Type in the items shown in Figures 83 thru 93 for each field. After completing a specification press "enter". In some cases the screen showing Field Input Validation Specifications may appear (figure 94). Do nothing to this screen, press "enter" and the field specification screen will reappear.

8. After entering the last field press PF key 16 to return to the Control File Menu. A control file now exists called INDEXQNT.

Continue pressing PF key 16 until the main Utility Menu is reached.

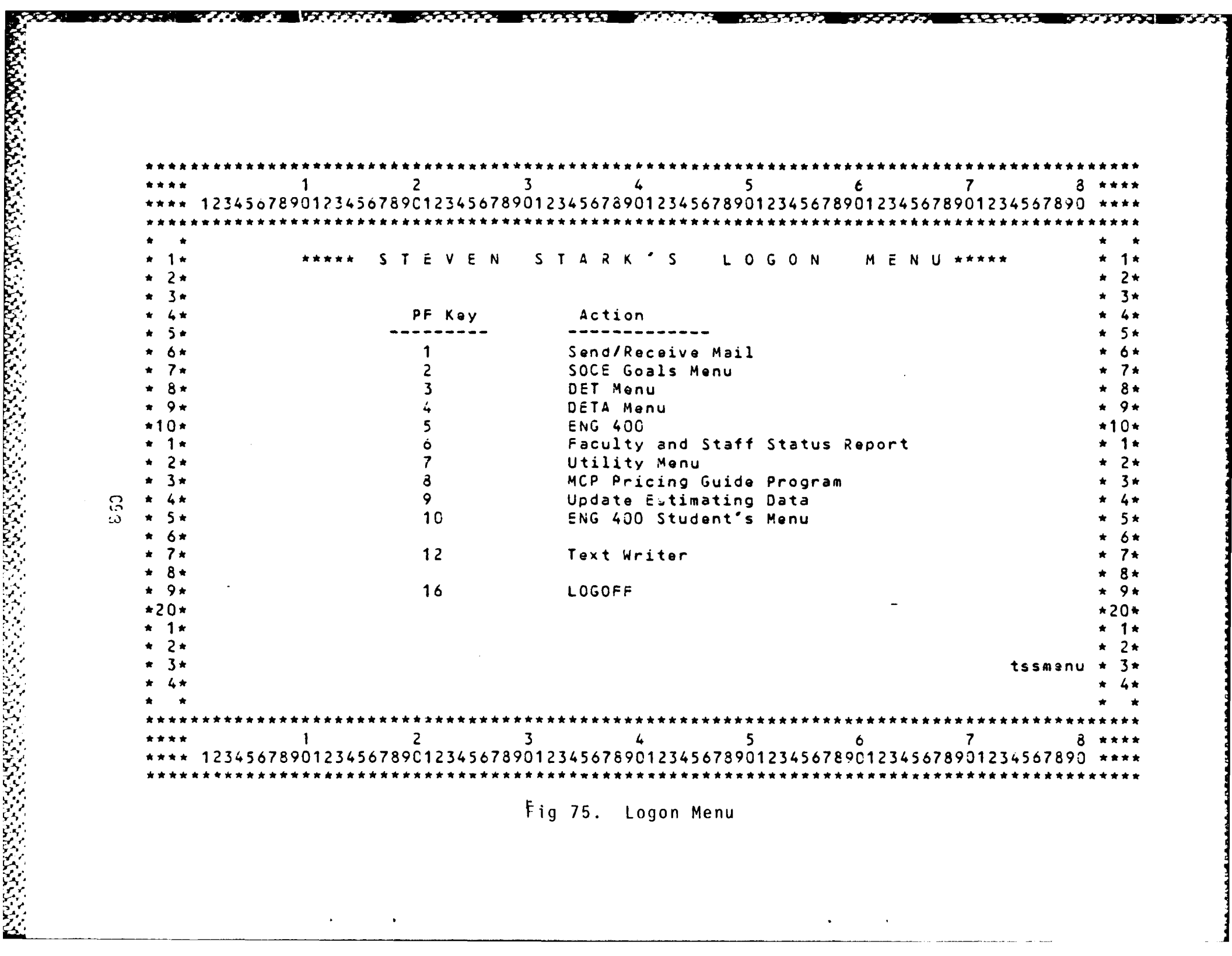

Fig 75. Logon Menu

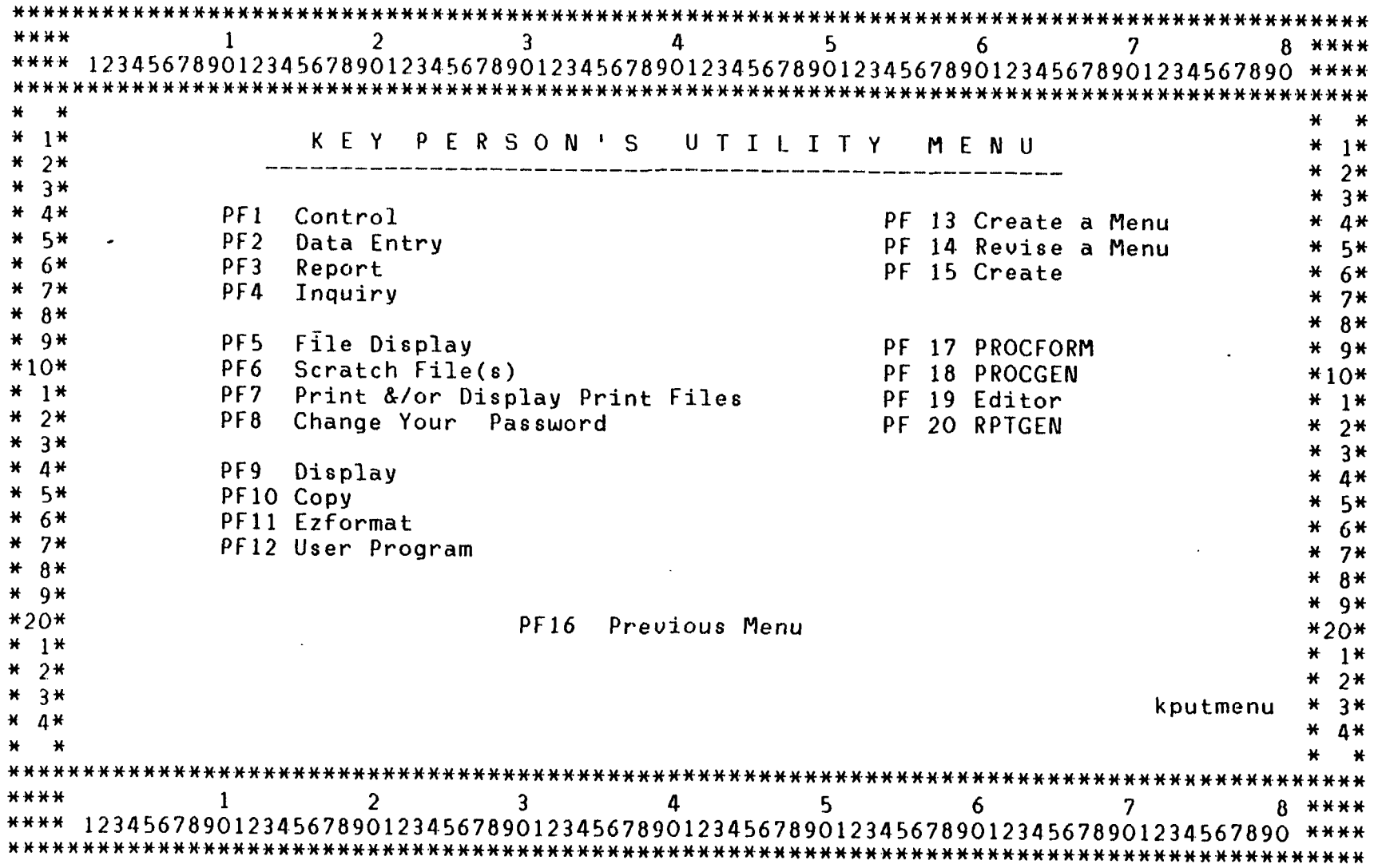

Fig 76. Utility Menu

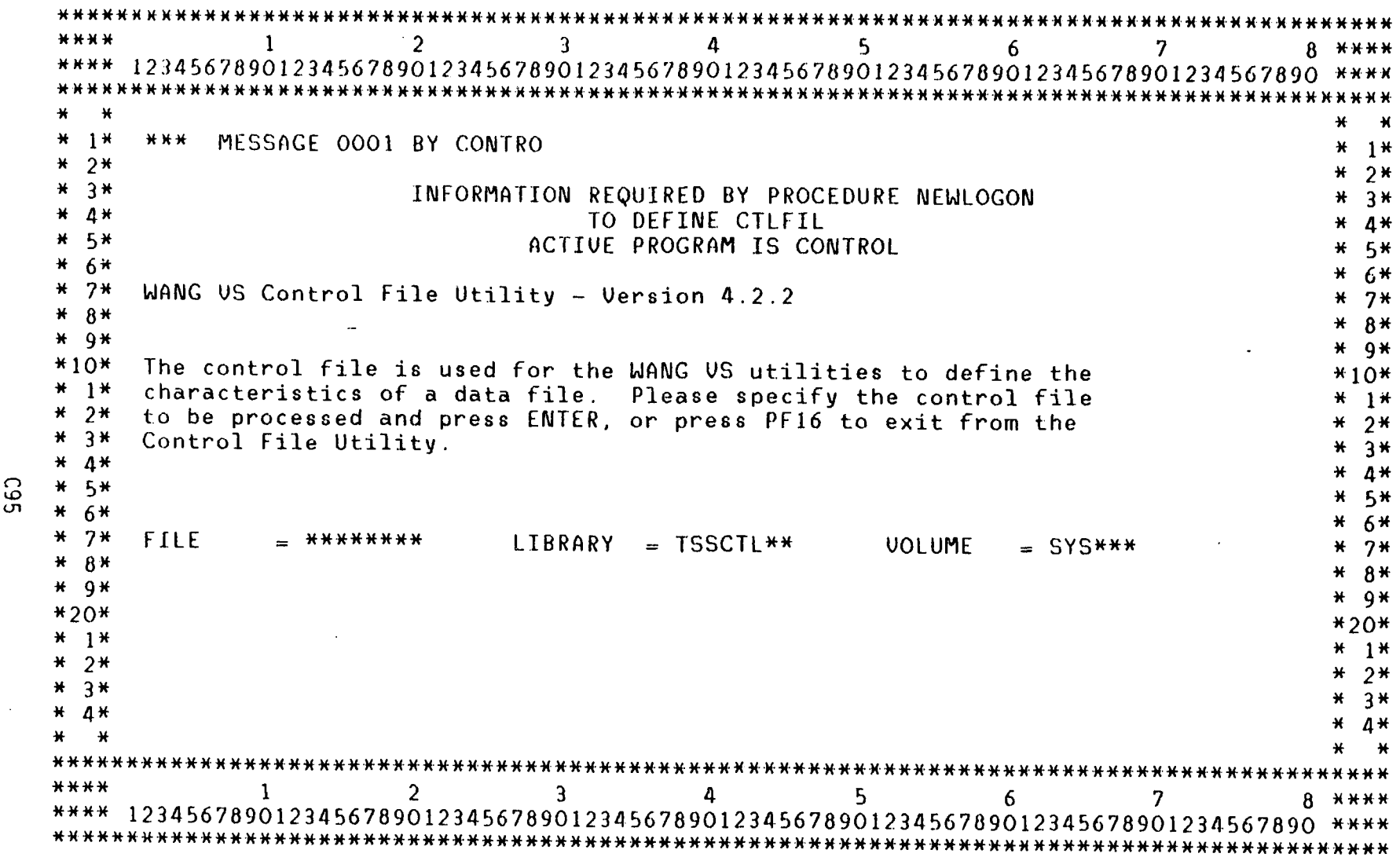

Fig 77. Control File Utility

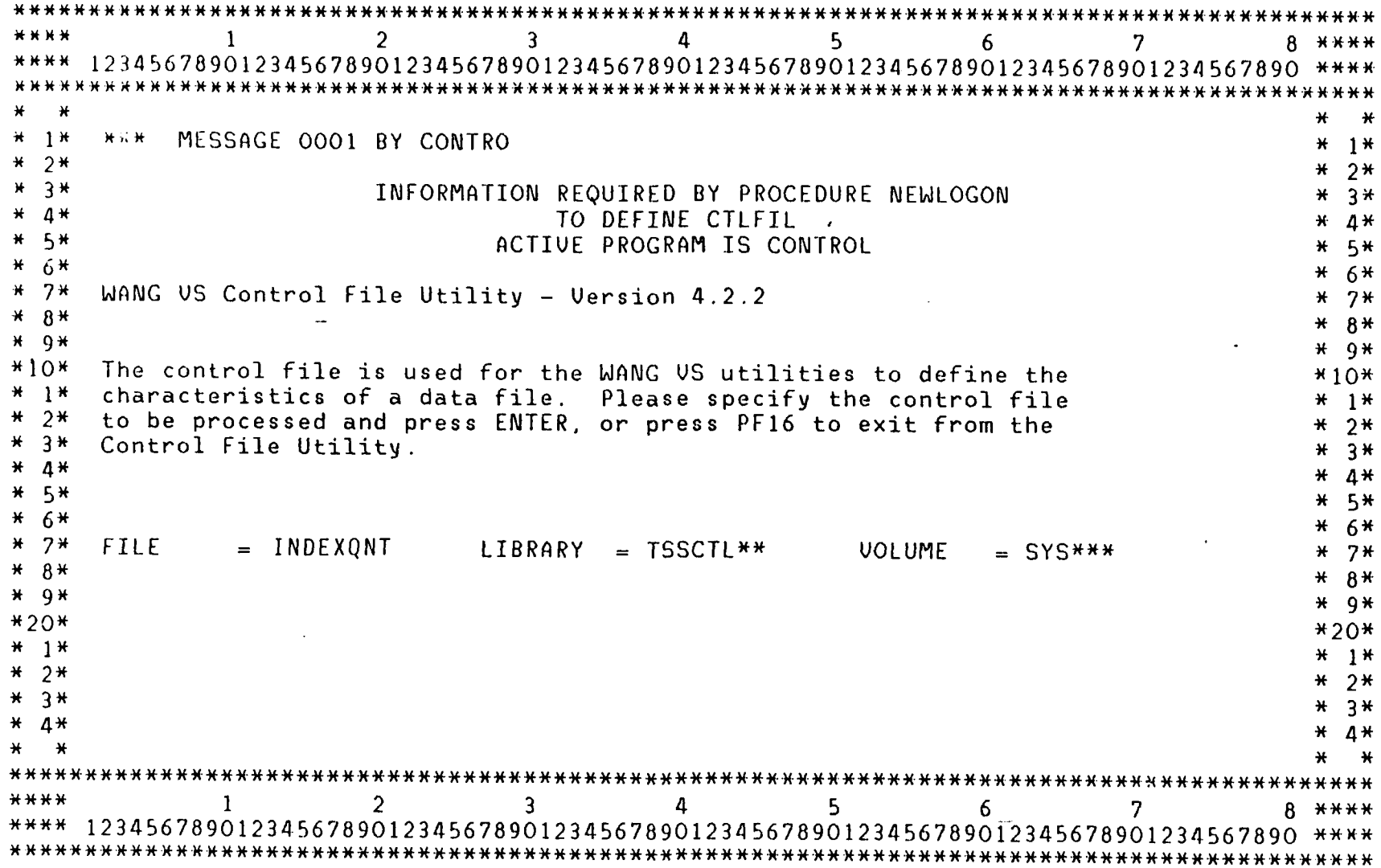

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Fig 78. Control File Utility

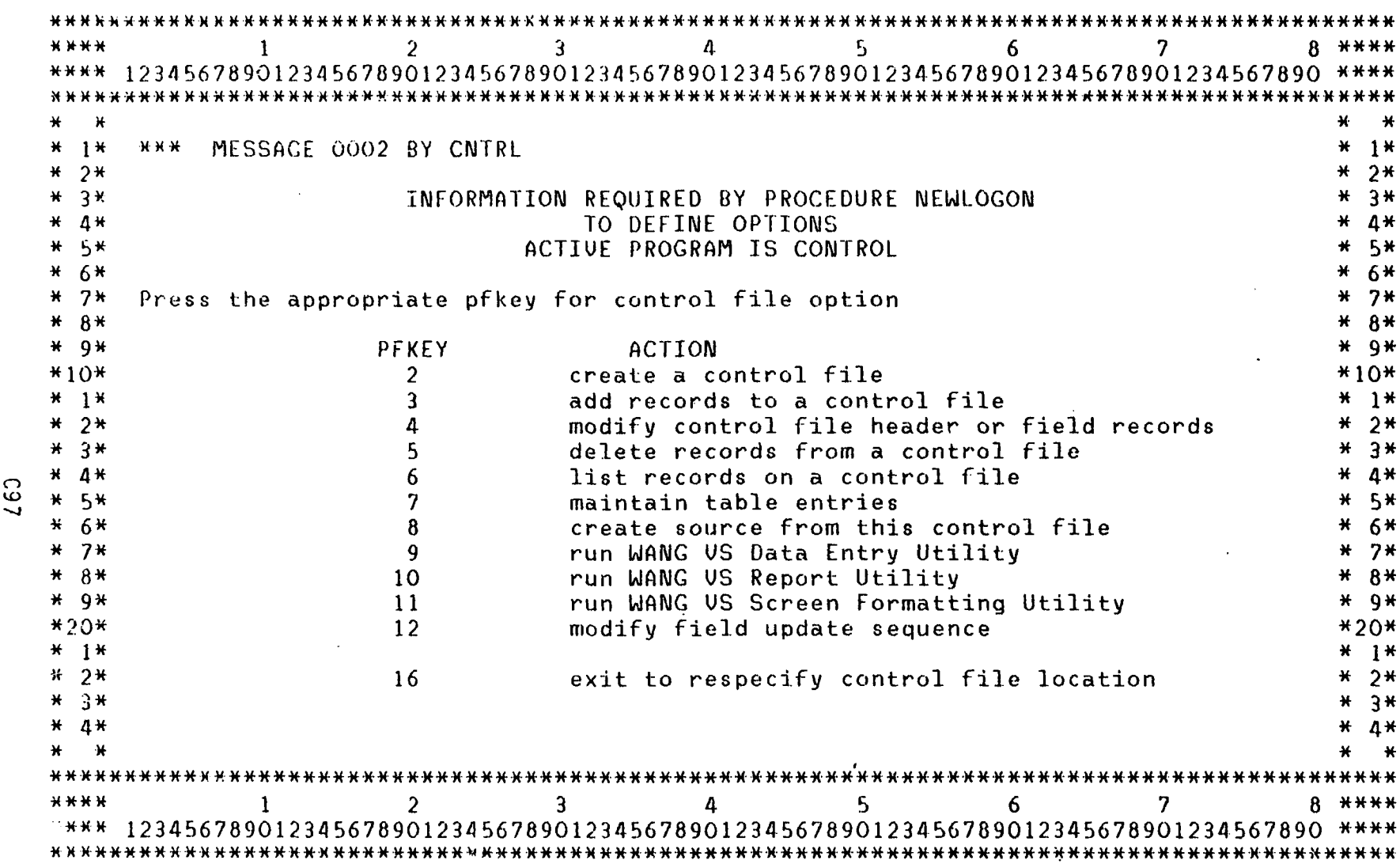


Fig 79. Control File Menu

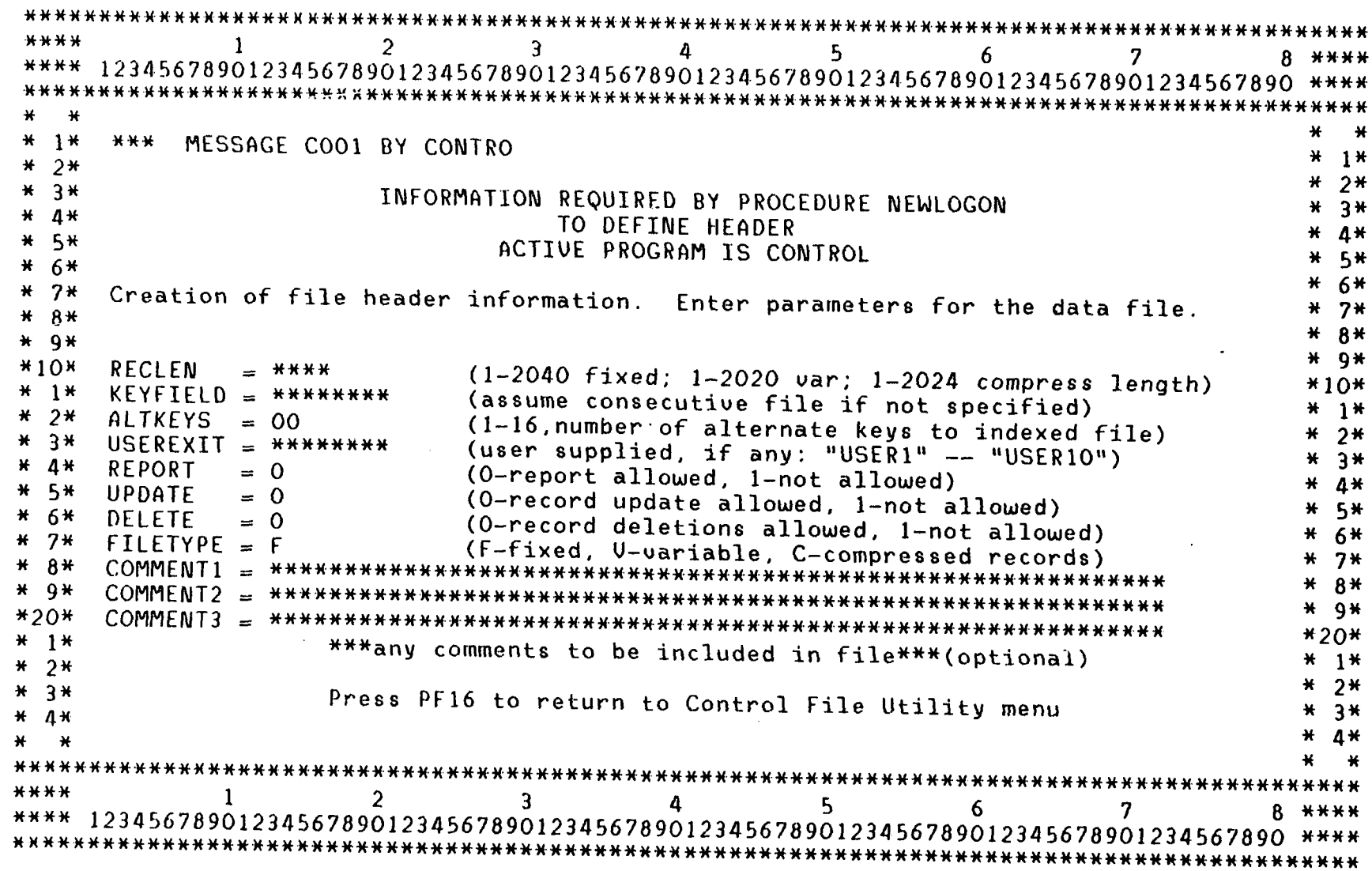


Fig 80. File Header

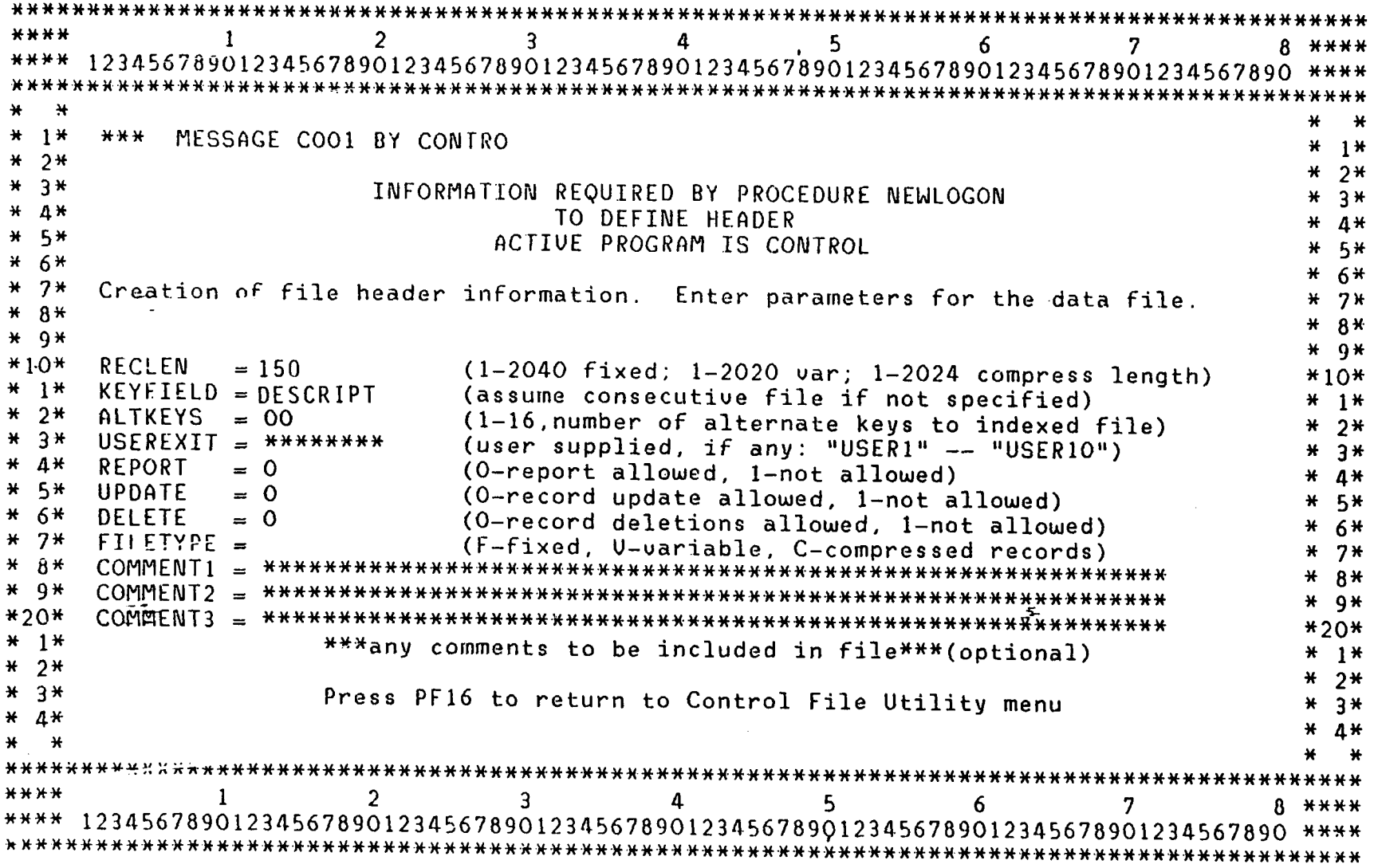
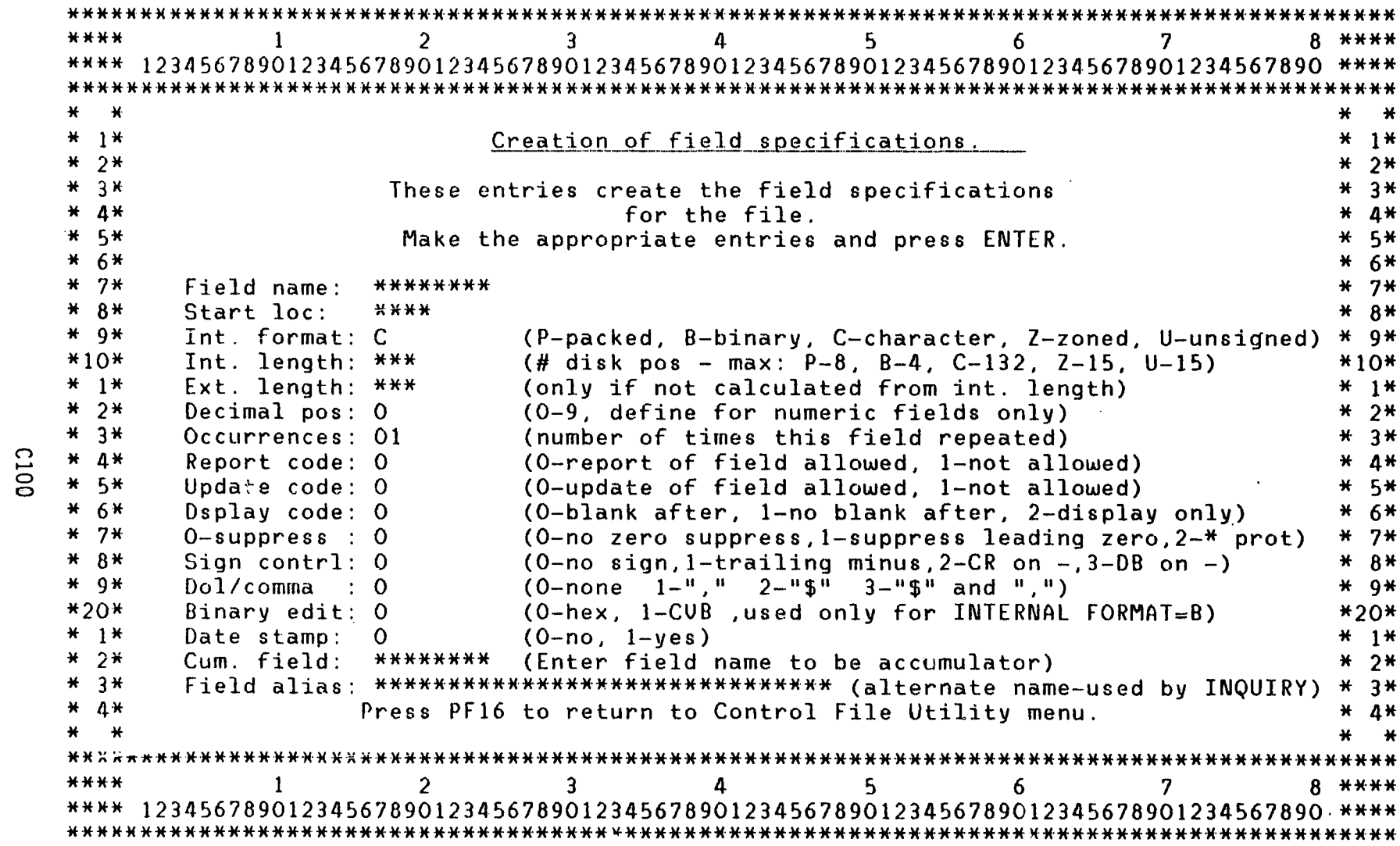


Fig 81. File Header Completed



C100

Fig 82. Field Specification

```
*****************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
*****************************************************************************
*  *                                                                        *  *
* 1*                      Creation of field specifications.                 * 1*
* 2*                                                                        * 2*
* 3*                  These entries create the field specifications         * 3*
* 4*                                  for the file.                         * 4*
* 5*                   Make the appropriate entries and press ENTER.        * 5*
* 6*                                                                        * 6*
* 7*    Field name:  UCI                                                    * 7*
* 8*    Start loc:  001                                                     * 8*
* 9*    Int. format: P         (P-packed, B-binary, C-character, Z-zoned, U-unsigned) * 9*
*10*    Int. length: 3         (# disk pos - max: P-8, B-4, C-132, Z-15, U-15)       *10*
* 1*    Ext. length: 6         (only if not calculated from int. length)            * 1*
* 2*    Decimal pos: 0         (0-9, define for numeric fields only)                * 2*
* 3*    Occurrences: 01        (number of times this field repeated)                * 3*
* 4*    Report code: 0         (0-report of field allowed, 1-not allowed)           * 4*
* 5*    Update code: 0         (0-update of field allowed, 1-not allowed)           * 5*
* 6*    Dsplay code: 0         (0-blank after, 1-no blank after, 2-display only)    * 6*
* 7*    0-suppress : 0         (0-no zero suppress,1-suppress leading zero,2-* prot) * 7*
* 8*    Sign contrl: 0         (0-no sign,1-trailing minus,2-CR on -,3-DB on -)      * 8*
* 9*    Dol/comma  : 0         (0-none  1-","  2-"$"  3-"$" and ",")                * 9*
*20*    Binary edit: 0         (0-hex, 1-CVB ,used only for INTERNAL FORMAT=B)       *20*
* 1*    Date stamp:  0         (0-no, 1-yes)                                        * 1*
* 2*    Cum. field:  ********  (Enter field name to be accumulator)                 * 2*
* 3*    Field alias: ******************************* (alternate name-used by INQUIRY) * 3*
* 4*                 Press PF16 to return to Control File Utility menu.           * 4*
*  *                                                                        *  *
*****************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
*****************************************************************************
```

CICJ

Fig 83. Field Specification for UCI

```
*****************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
*****************************************************************************
*  *                                                                          *  *
* 1*                        Creation of field specifications.                 * 1*
* 2*                                                                          * 2*
* 3*                  These entries create the field specifications           * 3*
* 4*                                  for the file.                           * 4*
* 5*                   Make the appropriate entries and press ENTER.          * 5*
* 6*                                                                          * 6*
* 7*    Field name:  CODE                                                     * 7*
* 8*    Start loc:  -004                                                      * 8*
* 9*    Int. format: P          (P-packed, B-binary, C-character, Z-zoned, U-unsigned) * 9*
*10*    Int. length: 7          (# disk pos - max: P-8, B-4, C-132, Z-15, U-15)  *10*
* 1*    Ext. length: 14         (only if not calculated from int. length)       * 1*
* 2*    Decimal pos: 0          (0-9, define for numeric fields only)           * 2*
* 3*    Occurrences: 01         (number of times this field repeated)           * 3*
* 4*    Report code: 0          (0-report of field allowed, 1-not allowed)      * 4*
* 5*    Update code: 0          (0-update of field allowed, 1-not allowed)      * 5*
* 6*    Dsplay code: 0          (0-blank after, 1-no blank after, 2-display only) * 6*
* 7*    0-suppress : 0          (0-no zero suppress,1-suppress leading zero,2-* prot) * 7*
* 8*    Sign contrl: 0          (0-no sign,1-trailing minus,2-CR on -,3-DB on -) * 8*
* 9*    Dol/comma  : 0          (0-none  1-","  2-"$"  3-"$" and ",")           * 9*
*20*    Binary edit: 0          (0-hex, 1-CVB ,used only for INTERNAL FORMAT=B)  *20*
* 1*    Date stamp:  0          (0-no, 1-yes)                                   * 1*
* 2*    Cum. field:  ********   (Enter field name to be accumulator)            * 2*
* 3*    Field alias: ******************************* (alternate name-used by INQUIRY) * 3*
* 4*                  Press PF16 to return to Control File Utility menu.      * 4*
*  *                                                                          *  *
*****************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
*****************************************************************************
```

C102

Fig 84. Field Specification for CODE

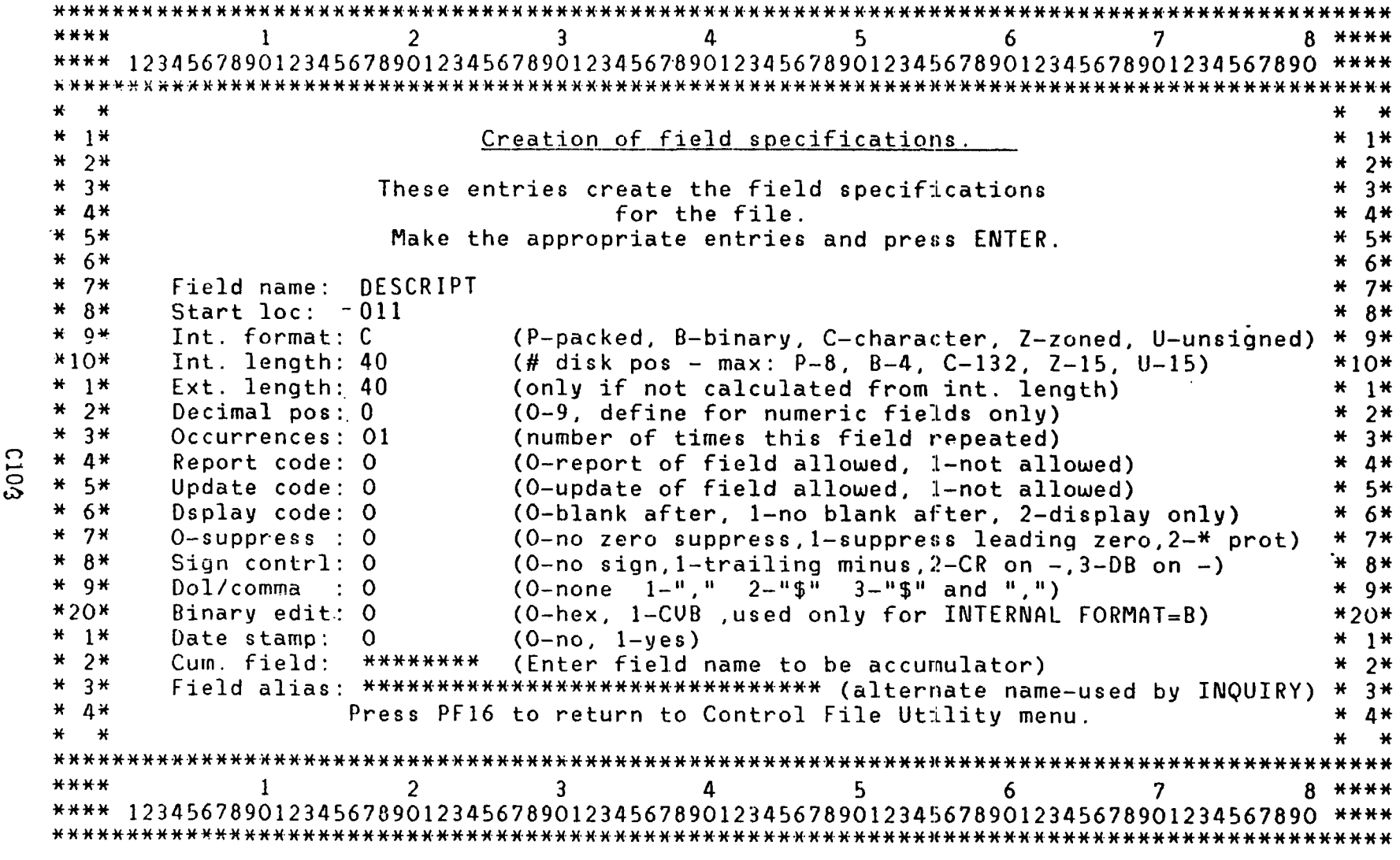


Fig 85. Field Specification for DESCRIPT

```
*******************************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 1234567890123456789012345678901234567890123456789012345678901234567890123456789 0 ****
*******************************************************************************************
*  *                                                                                 *  *
* 1*                        Creation of field specifications.                        * 1*
* 2*                                                                                 * 2*
* 3*                  These entries create the field specifications                  * 3*
* 4*                                  for the file.                                  * 4*
* 5*                  Make the appropriate entries and press ENTER.                  * 5*
* 6*                                                                                 * 6*
* 7*    Field name:   CREWSIZE                                                       * 7*
* 8*    Start loc:  - 051                                                            * 8*
* 9*    Int. format: C        (P-packed, B-binary, C-character, Z-zoned, U-unsigned) * 9*
*10*    Int. length: 5        (# disk pos - max: P-8, B-4, C-132, Z-15, U-15)        *10*
* 1*    Ext. length: 5        (only if not calculated from int. length)              * 1*
* 2*    Decimal pos:, 0       (0-9, define for numeric fields only)                  * 2*
* 3*    Occurrences: 01       (number of times this field repeated)                  * 3*
* 4*    Report code: 0        (0-report of field allowed, 1-not allowed)             * 4*
* 5*    Update code: 0        (0-update of field allowed, 1-not allowed)             * 5*
* 6*    Dsplay code: 0        (0-blank after, 1-no blank after, 2-display only)      * 6*
* 7*    0-suppress  : 0       (0-no zero suppress,1-suppress leading zero,2-* prot)  * 7*
* 8*    Sign contrl: 0        (0-no sign,1-trailing minus,2-CR on -,3-DB on -)       * 8*
* 9*    Dol/comma   : 0       (0-none  1-","  2-"$"  3-"$" and ",")                  * 9*
*20*    Binary edit: 0        (0-hex, 1-CVB ,used only for INTERNAL FORMAT=B)        *20*
* 1*    Date stamp:  0        (0-no, 1-yes)                                          * 1*
* 2*    Cum. field:  ******** (Enter field name to be accumulator)                   * 2*
* 3*    Field alias: ****************************** (alternate name-used by INQUIRY) * 3*
* 4*                Press PF16 to return to Control File Utility menu.               * 4*
*  *                                                                                 *  *
*******************************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 1234567890123456789012345678901234567890123456789012345678901234567890123456789 0 ****
*******************************************************************************************
```

Fig 86. Field Specification for CREWSIZE

```
********************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
********************************************************************************
*  *                                                                           *  *
* 1*                        Creation of field specifications.                  * 1*
* 2*                                                                           * 2*
* 3*                   These entries create the field specifications           * 3*
* 4*                                  for the file.                            * 4*
* 5*                    Make the appropriate entries and press ENTER.          * 5*
* 6*                                                                           * 6*
* 7*    Field name:  OUTPUT                                                    * 7*
* 8*    Start loc:   056                                                       * 8*
* 9*    Int. format: P          (P-packed, B-binary, C-character, Z-zoned, U-unsigned) * 9*
*10*    Int. length: 5          (# disk pos - max: P-8, B-4, C-132, Z-15, U-15)       *10*
* 1*    Ext. length: 10         (only if not calculated from int. length)            * 1*
* 2*    Decimal pos: 0          (0-9, define for numeric fields only)                * 2*
* 3*    Occurrences: 01         (number of times this field repeated)                * 3*
* 4*    Report code: 0          (0-report of field allowed, 1-not allowed)           * 4*
* 5*    Update code: 0          (0-update of field allowed, 1-not allowed)           * 5*
* 6*    Dsplay code: 0          (0-blank after, 1-no blank after, 2-display only)    * 6*
* 7*    0-suppress : 0          (0-no zero suppress,1-suppress leading zero,2-* prot) * 7*
* 8*    Sign contrl: 0          (0-no sign,1-trailing minus,2-CR on -,3-DB on -)      * 8*
* 9*    Dol/comma  : 0          (0-none  1-","  2-"$"  3-"$" and ",")                * 9*
*20*    Binary edit: 0          (0-hex, 1-CVB ,used only for INTERNAL FORMAT=B)       *20*
* 1*    Date stamp:  0          (0-no, 1-yes)                                        * 1*
* 2*    Cum. field:  ********   (Enter field name to be accumulator)                 * 2*
* 3*    Field alias: ********************************* (alternate name-used by INQUIRY) * 3*
* 4*                 Press PF16 to return to Control File Utility menu.            * 4*
*  *                                                                           *  *
********************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
********************************************************************************
```

C105

Fig 87. Field Specification for OUTPUT

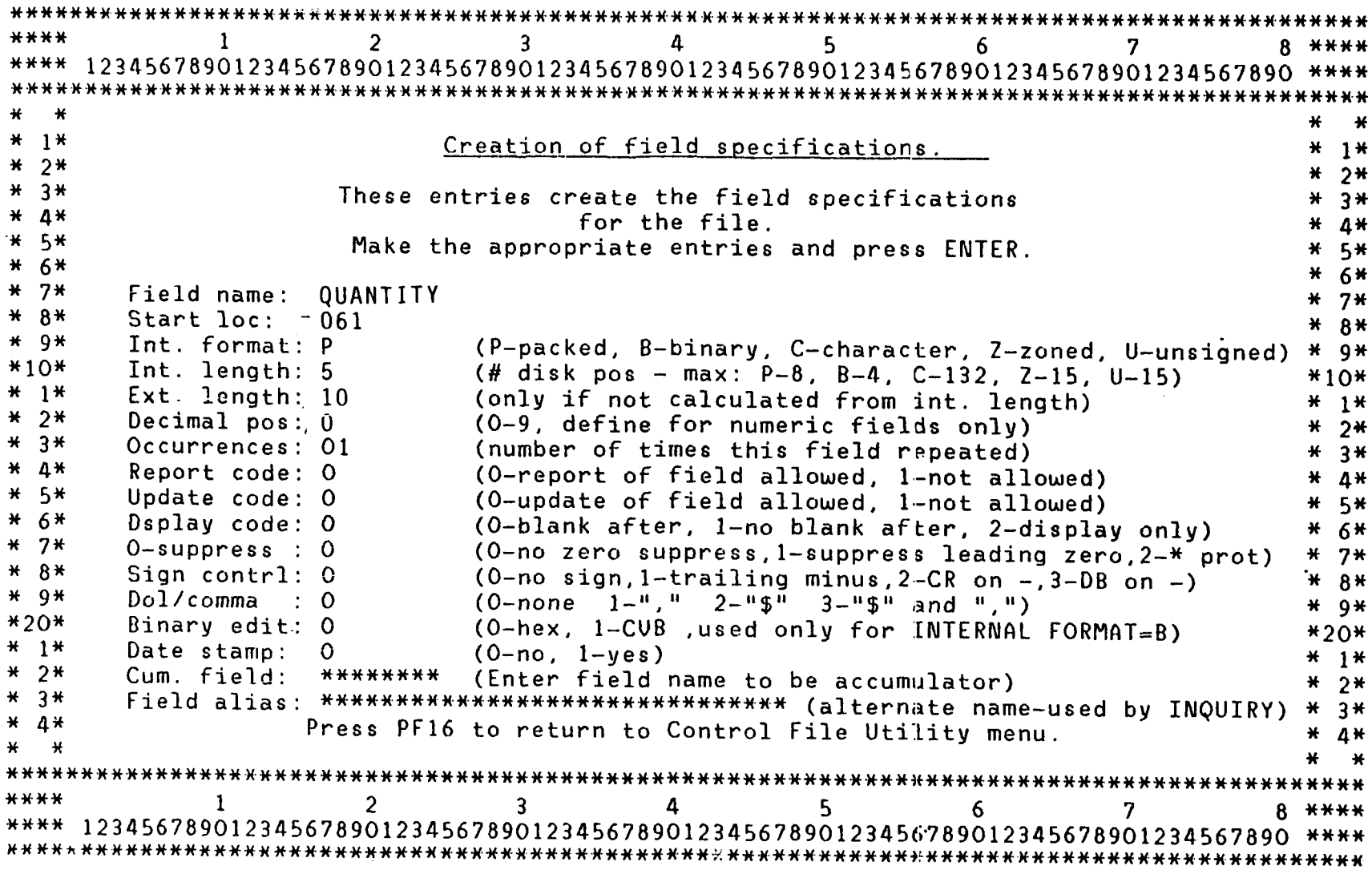


Fig 88. Field Specification QUANTITY

```
**********************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 123456789012345678901234567890123456789012345678901234567890123456789012345678 ****
**********************************************************************************
*  *                                                                             *  *
* 1*                        Creation of field specifications.                    * 1*
* 2*                                                                             * 2*
* 3*                    These entries create the field specifications            * 3*
* 4*                                  for the file.                              * 4*
* 5*                     Make the appropriate entries and press ENTER.           * 5*
* 6*                                                                             * 6*
* 7*     Field name:  UNITS                                                      * 7*
* 8*     Start loc:  066                                                         * 8*
* 9*     Int. format: C          (P-packed, B-binary, C-character, Z-zoned, U-unsigned) * 9*
*10*     Int. length: 5          (# disk pos - max: P-8, B-4, C-132, Z-15, U-15)  *10*
* 1*     Ext. length: 5          (only if not calculated from int. length)       * 1*
* 2*     Decimal pos: 0          (0-9, define for numeric fields only)           * 2*
* 3*     Occurrences: 01         (number of times this field repeated)           * 3*
* 4*     Report code: 0          (0-report of field allowed, 1-not allowed)      * 4*
* 5*     Update code: 0          (0-update of field allowed, 1-not allowed)      * 5*
* 6*     Dsplay code: 0          (0-blank after, 1-no blank after, 2-display only) * 6*
* 7*     0-suppress : 0          (0-no zero suppress,1-suppress leading zero,2-* prot) * 7*
* 8*     Sign contrl: 0          (0-no sign,1-trailing minus,2-CR on -,3-DB on -) * 8*
* 9*     Dol/comma  : 0          (0-none  1-","  2-"$"  3-"$" and ",")           * 9*
*20*     Binary edit: 0          (0-hex, 1-CVB ,used only for INTERNAL FORMAT=B)  *20*
* 1*     Date stamp:  0          (0-no, 1-yes)                                   * 1*
* 2*     Cum. field:  ********   (Enter field name to be accumulator)            * 2*
* 3*     Field alias: ********************************* (alternate name-used by INQUIRY) * 3*
* 4*                  Press PF16 to return to Control File Utility menu.         * 4*
*  *                                                                             *  *
**********************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 123456789012345678901234567890123456789012345678901234567890123456789012345678 ****
**********************************************************************************
```

Fig 89. Field Specification for UNITS

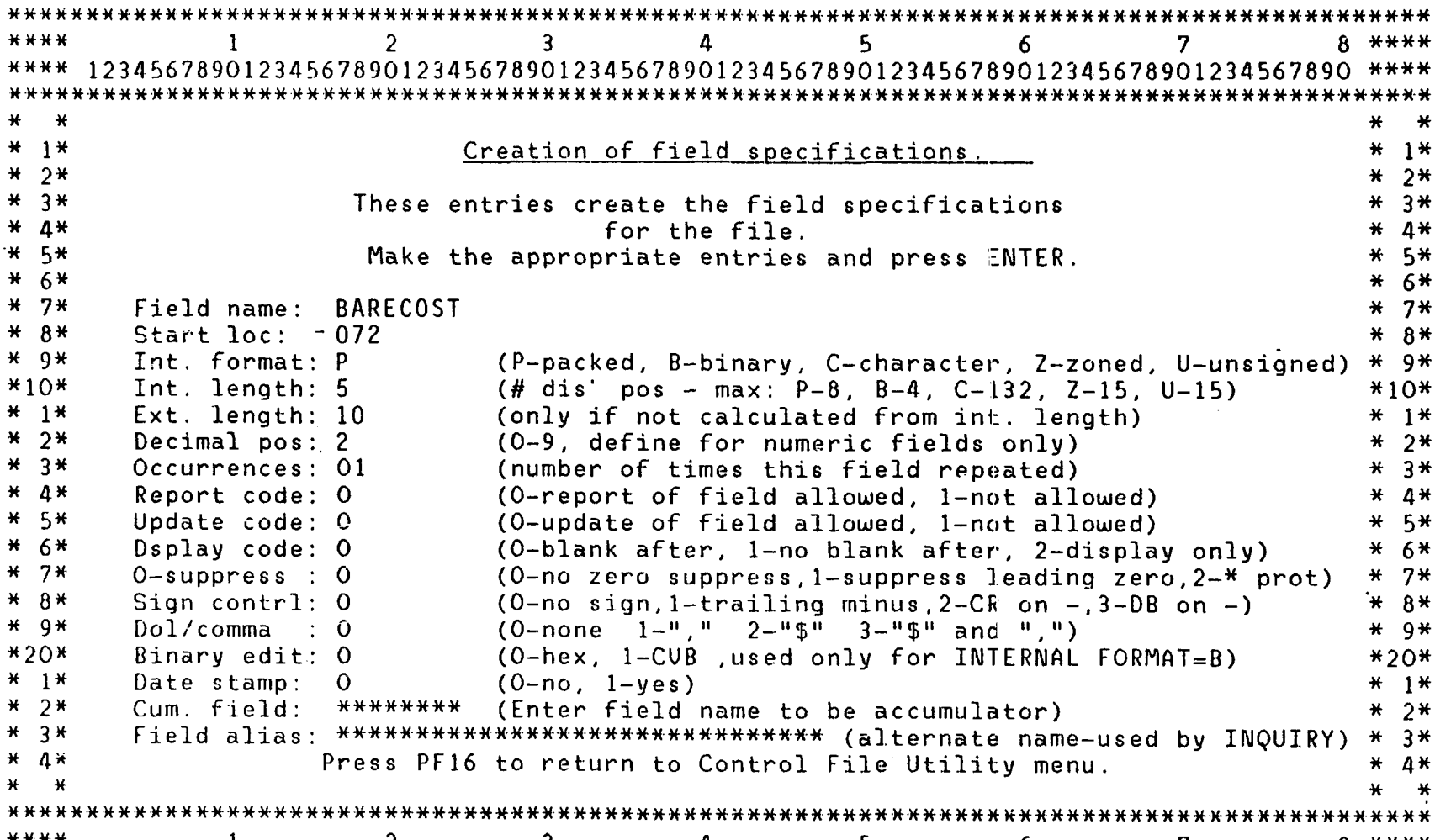


Fig 90. Field Specifications for BARECOST

```
**********************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
**********************************************************************************
*  *                                                                             *  *
* 1*                        Creation of field specifications.                    * 1*
* 2*                                                                             * 2*
* 3*                  These entries create the field specifications              * 3*
* 4*                                  for the file.                              * 4*
* 5*                   Make the appropriate entries and press ENTER.             * 5*
* 6*                                                                             * 6*
* 7*     Field name:  TOTAL                                                      * 7*
* 8*     Start loc:  -078                                                        * 8*
* 9*     Int. format: P          (P-packed, B-binary, C-character, Z-zoned, U-unsigned) * 9*
*10*     Int. length: 5          (# disk pos - max: P-8, B-4, C-132, Z-15, U-15)  *10*
* 1*     Ext. length: 10         (only if not calculated from int. length)       * 1*
* 2*     Decimal pos: 2          (0-9, define for numeric fields only)           * 2*
* 3*     Occurrences: 01         (number of times this field repeated)           * 3*
* 4*     Report code: 0          (0-report of field allowed, 1-not allowed)      * 4*
* 5*     Update code: 0          (0-update of field allowed, 1-not allowed)      * 5*
* 6*     Dsplay code: 0          (0-blank after, 1-no blank after, 2-display only) * 6*
* 7*     0-suppress : 0          (0-no zero suppress,1-suppress leading zero,2-* prot) * 7*
* 8*     Sign contrl: 0          (0-no sign,1-trailing minus,2-CR on -,3-DB on -) * 8*
* 9*     Dol/comma  : 0          (0-none  1-","  2-"$"  3-"$" and ",")           * 9*
*20*     Binary edit: 0          (0-hex, 1-CVB ,used only for INTERNAL FORMAT=B) *20*
* 1*     Date stamp:  0          (0-no, 1-yes)                                   * 1*
* 2*     Cum. field:  ********   (Enter field name to be accumulator)            * 2*
* 3*     Field alias: ********************************* (alternate name-used by INQUIRY) * 3*
* 4*                  Press PF16 to return to Control File Utility menu.         * 4*
*  *                                                                             *  *
**********************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
**********************************************************************************
```

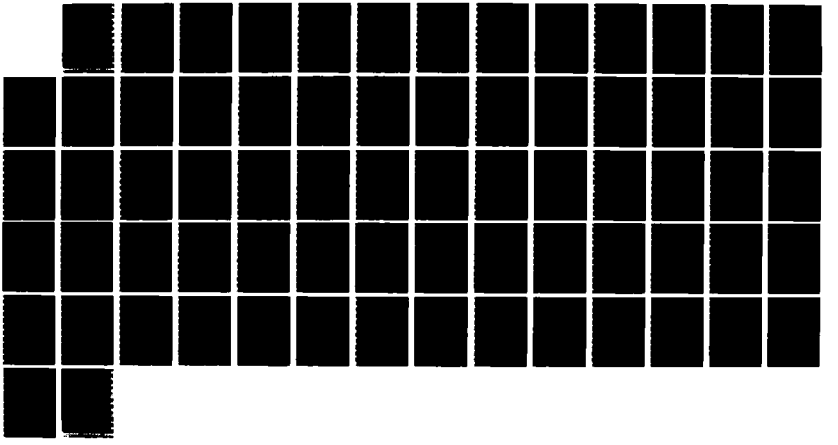
C109

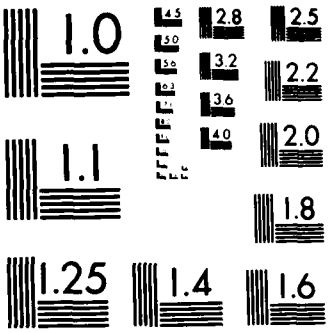
Fig 91. Field Specification for TOTAL

```
*****************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
*****************************************************************************
*  *                                                                        *  *
* 1*                        Creation of field specifications.               * 1*
* 2*                                                                        * 2*
* 3*                   These entries create the field specifications        * 3*
* 4*                                  for the file.                         * 4*
* 5*                    Make the appropriate entries and press ENTER.       * 5*
* 6*                                                                        * 6*
* 7*     Field name:  TOTBARE                                               * 7*
* 8*     Start loc:   084                                                   * 8*
* 9*     Int. format: P          (P-packed, B-binary, C-character, Z-zoned, U-unsigned) * 9*
*10*     Int. length: 7          (# disk pos - max: P-8, B-4, C-132, Z-15, U-15)       *10*
* 1*     Ext. length: 14         (only if not calculated from int. length)            * 1*
* 2*     Decimal pos: 2          (0-9, define for numeric fields only)                * 2*
* 3*     Occurrences: 01         (number of times this field repeated)                * 3*
* 4*     Report code: 0          (0-report of field allowed, 1-not allowed)           * 4*
* 5*     Update code: 0          (0-update of field allowed, 1-not allowed)           * 5*
* 6*     Dsplay code: 0          (0-blank after, 1-no blank after, 2-display only)    * 6*
* 7*     0-suppress : 0          (0-no zero suppress,1-suppress leading zero,2-* prot) * 7*
* 8*     Sign contrl: 0          (0-no sign,1-trailing minus,2-CR on -,3-DB on -)      * 8*
* 9*     Dol/comma  : 0          (0-none  1-","  2-"$"  3-"$" and ",")                * 9*
*20*     Binary edit: 0          (0-hex, 1-CVB ,used only for INTERNAL FORMAT=B)       *20*
* 1*     Date stamp:  0          (0-no, 1-yes)                                        * 1*
* 2*     Cum. field:  ********   (Enter field name to be accumulator)                * 2*
* 3*     Field alias: ********************************* (alternate name-used by INQUIRY) * 3*
* 4*                  Press PF16 to return to Control File Utility menu.            * 4*
*  *                                                                        *  *
*****************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
*****************************************************************************
```

Fig 92. Field Specification for TOTBARE

AD-A175 001 FORMULATION OF A CONSTRUCTION COST ESTIMATING PROCEDURE 3/3
TO AID DESIGNERS I (U) AIR FORCE INST OF TECH
WRIGHT-PATTERSON AFB OH SCHOOL OF SYST S R STARK
UNCLASSIFIED SEP 86 AFIT/GEM/LSA/86S-26 F/G 14/1 NL





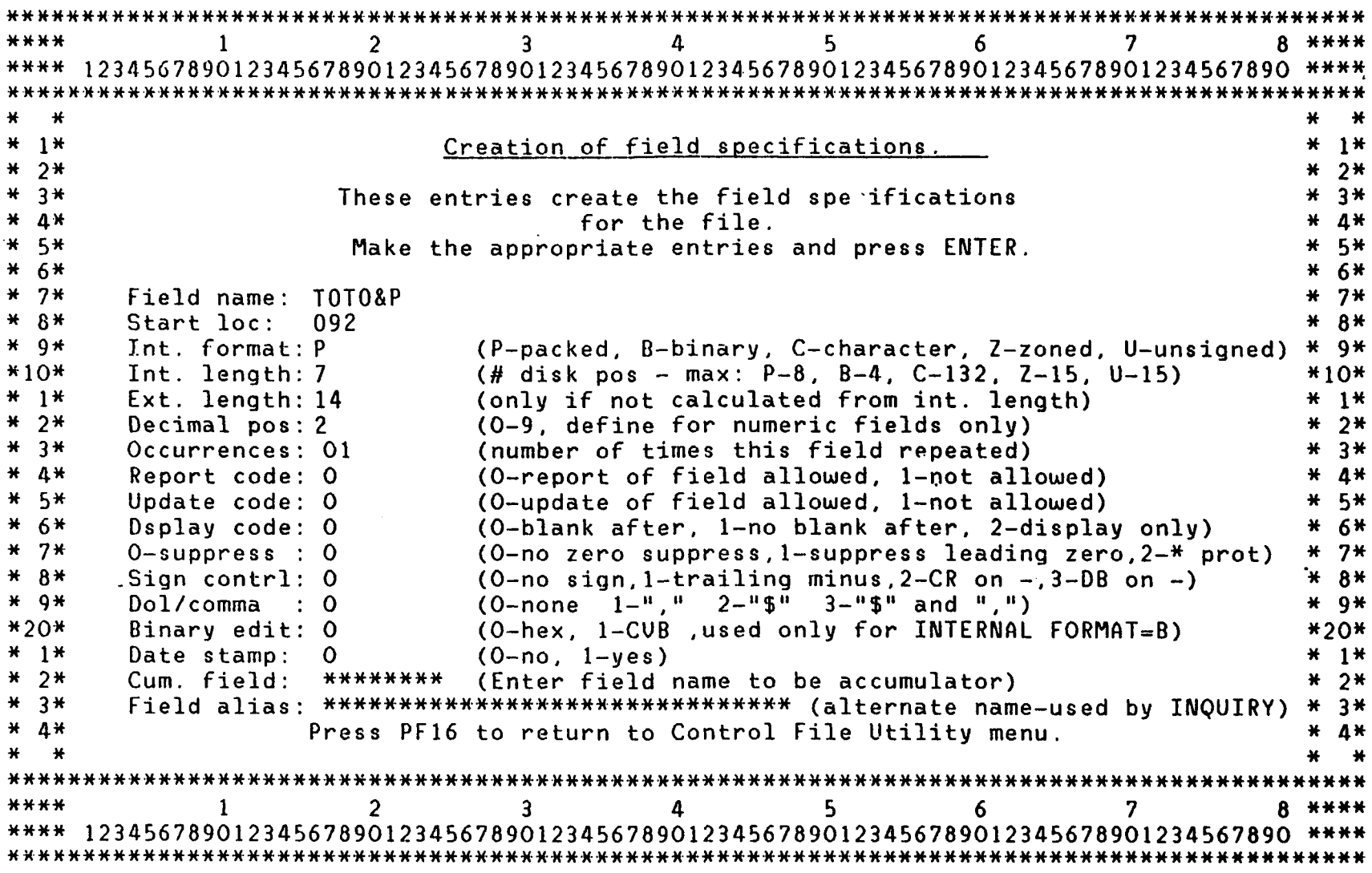
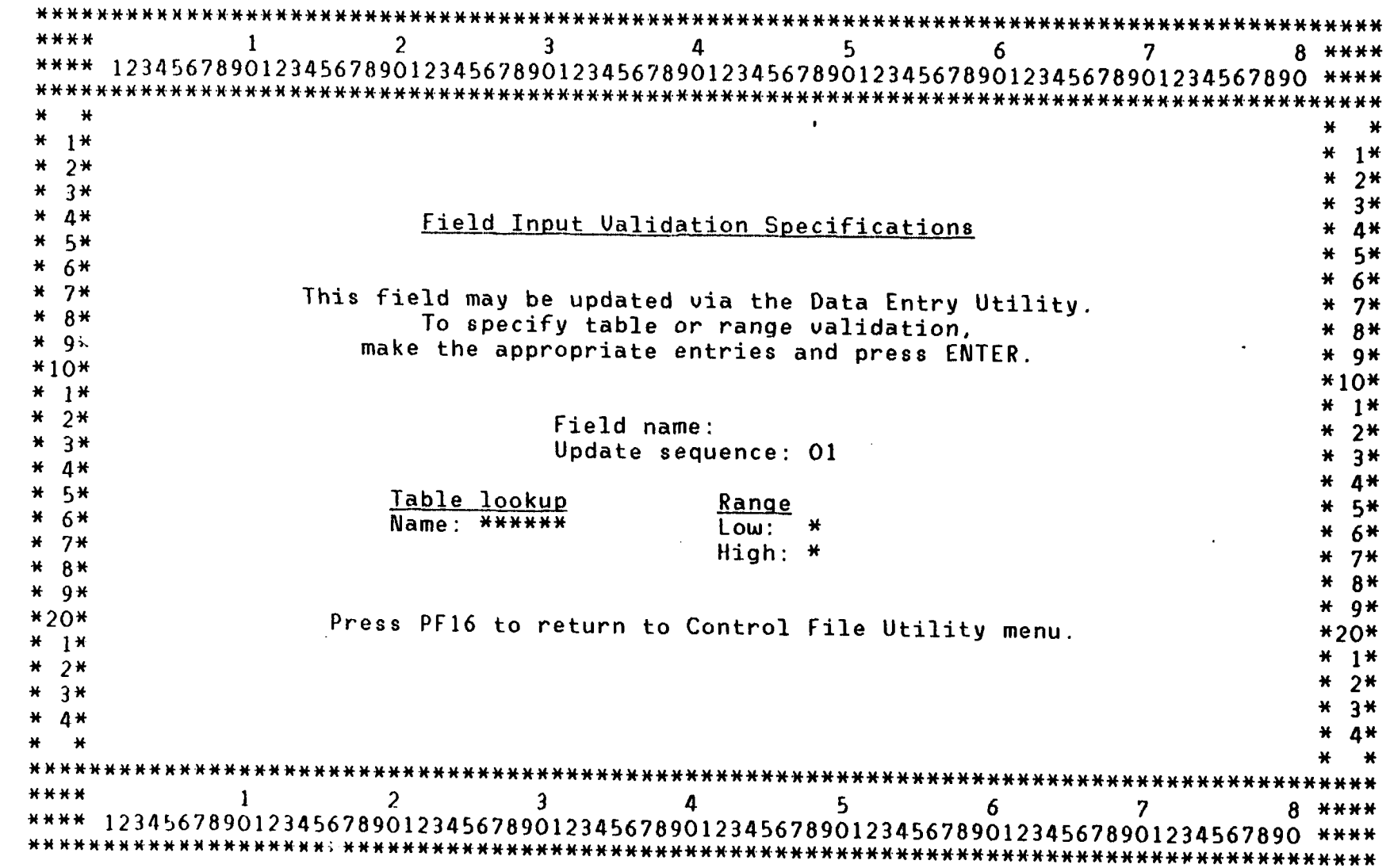


Fig 93. Field Specification for TOTO&P



C112

Fig 94. Field Input Validation

Modifications to the Quantity Project Data File:

1. Press the PF key opposite Data Entry, in this example it's PF key 2 (figure 95).

2. The computer now prompts for the data file and the control file as shown in figure 96. Type in the items shown in figure 97 and press "enter".

3. The data entry menu is now on the monitor (figure 98). To Modify a record in the file press PF key 4.

4. The next screen (figure 99) must now be completed. The description is exactly the same as when the item was originally entered into the data file.

5. The next screen displays the record to be modified (figure 100). All the items can now be changed except the DESCRIPT field. After changes are made press "enter" to modify the file. If "enter" is not pressed the changes are not made.

6. Press PF key 16 to exit.

Deletion of Files From the Quantity Project Data File:

1. Repeat steps 1 and 2 under modifications to the data base.

2. Press PF key 5 as shown in figure 98 to delete records from a data file.

3. The next screen (figure 101) is very similar to the screen used to make modifications. Type in the DESCRIPT for the record to be deleted and press "enter". If the DESCRIPT can be found in the data the record will be deleted, if not, a message will appear on the screen indication "record could not be found".

4. Press PF key 16 to exit.

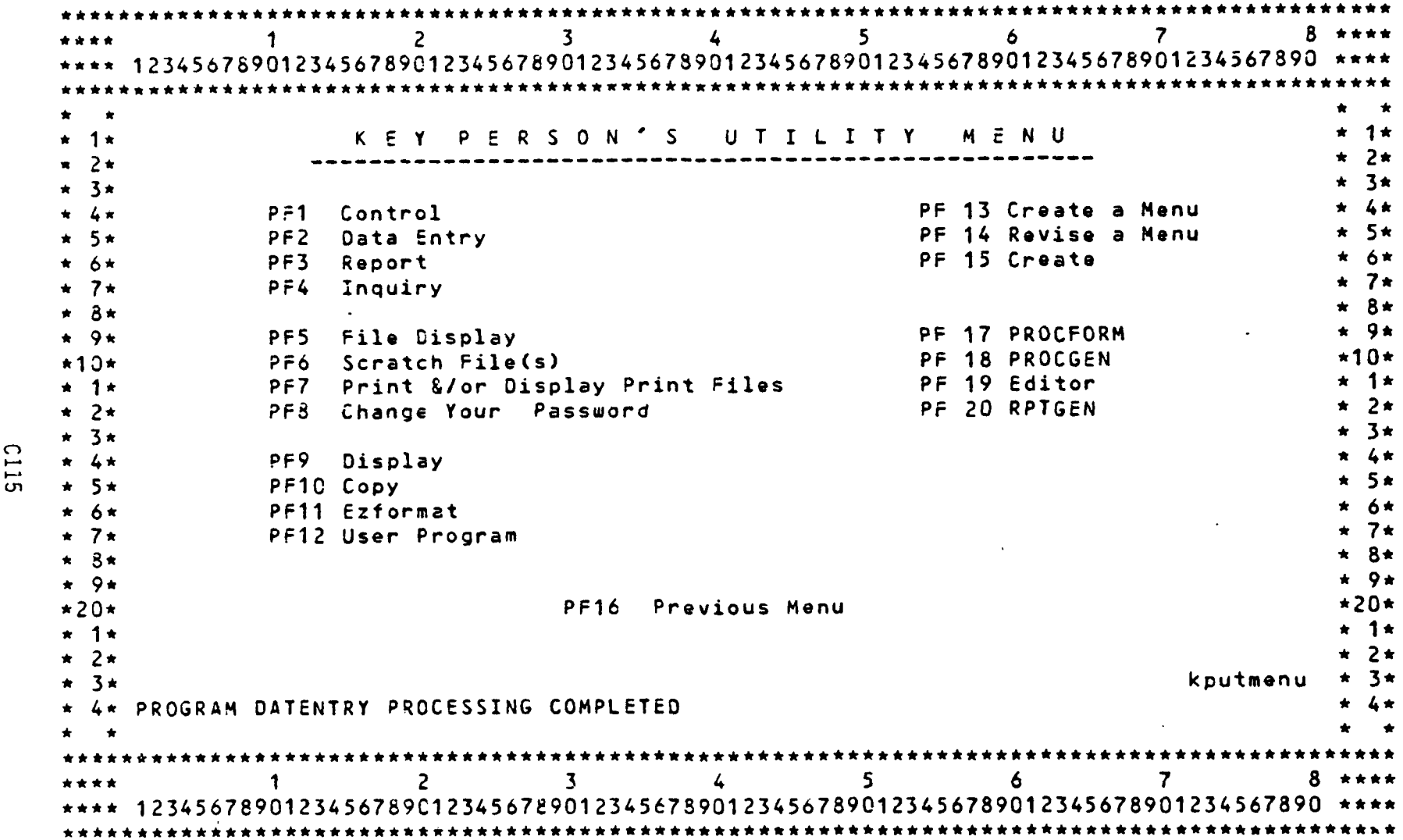


Fig 95. Utility Menu

```
**********************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
**********************************************************************************
*  *                                                                             *  *
* 1*  ***  MESSAGE 0001 BY DATENT                                                * 1*
* 2*                                                                             * 2*
* 3*                    INFORMATION REQUIRED BY PROCEDURE NEWLOGON                * 3*
* 4*                                TO DEFINE INPUT                              * 4*
* 5*                           ACTIVE PROGRAM IS DATENTRY                        * 5*
* 6*                                                                             * 6*
* 7*               Specify the data/control files and press ENTER                * 7*
* 8*                                                                             * 8*
* 9*                                                                             * 9*
*10*  Please specify the data file:                                             *10*
* 1*  FILE      = ********                                                       * 1*
* 2*  LIBRARY   = ********                                                       * 2*
* 3*  VOLUME    = SYS***                                                        * 3*
* 4*                                                                             * 4*
* 5*  and the control file:                                                     * 5*
* 6*  CTLFILE   = ********                                                       * 6*
* 7*  CTLLIB    = TSSCTL**                                                      * 7*
* 8*  CTLVOL    = SYS***                                                        * 8*
* 9*                                                                             * 9*
*20*                    Press PF16 to exit the DATENTRY Utility                 *20*
* 1*            <<<<<< WANG VS Data Entry Utility - Version 4.02.07 >>>>>>      * 1*
* 2*                                                                             * 2*
* 3*                                                                             * 3*
* 4*                                                                             * 4*
*  *                                                                             *  *
**********************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
**********************************************************************************
```

Fig 96. Data Entry Information

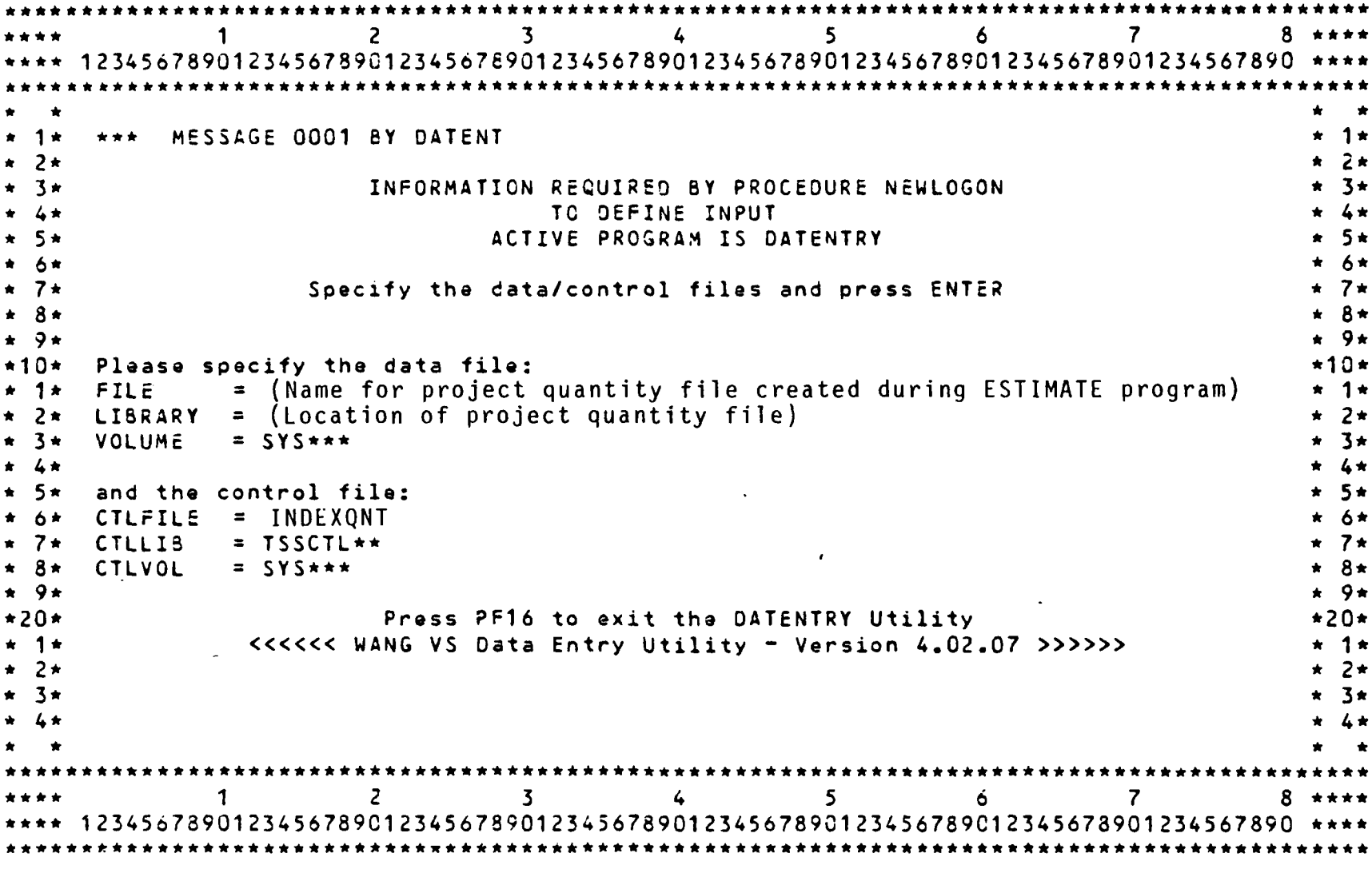


Fig 97. Example Data Entry

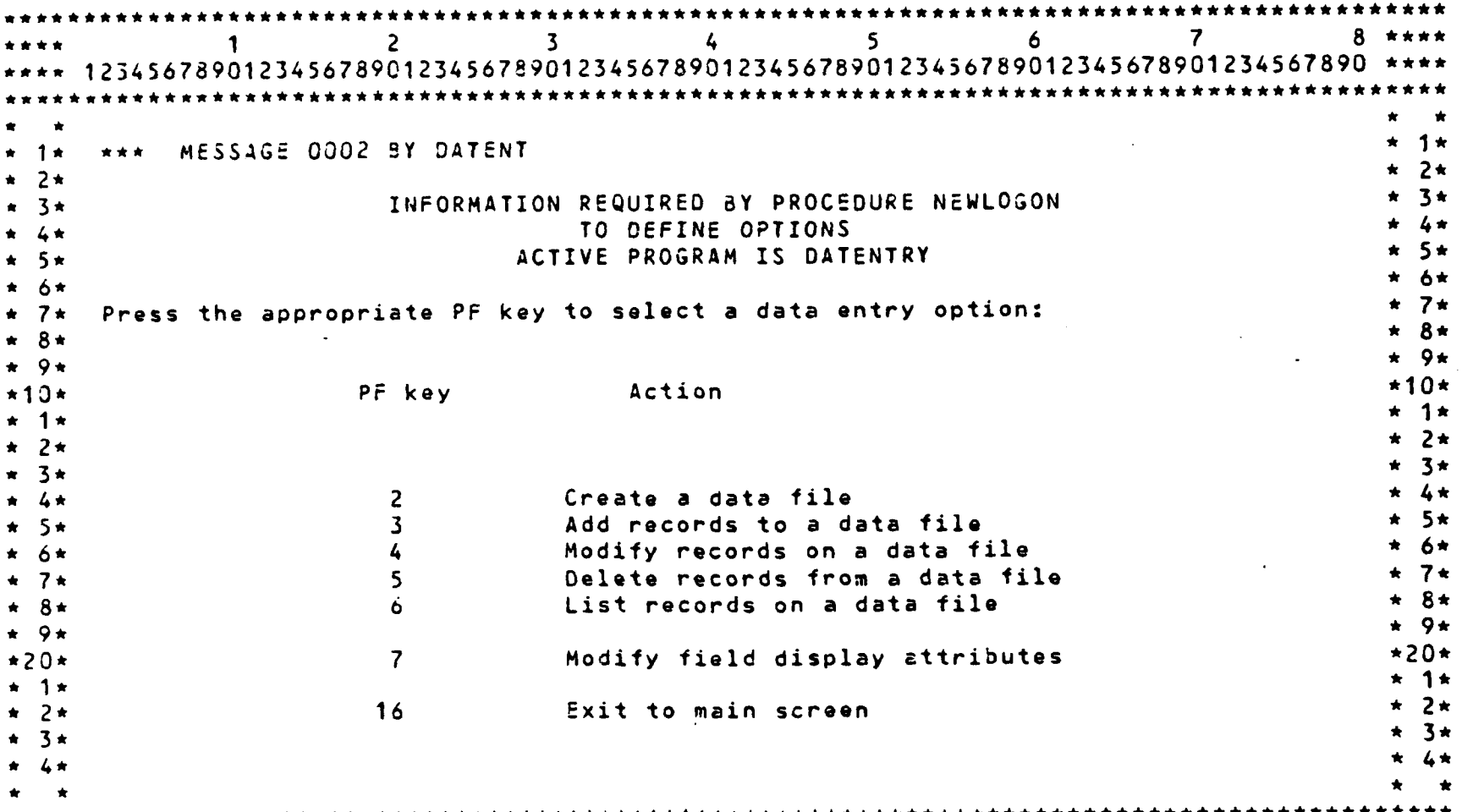
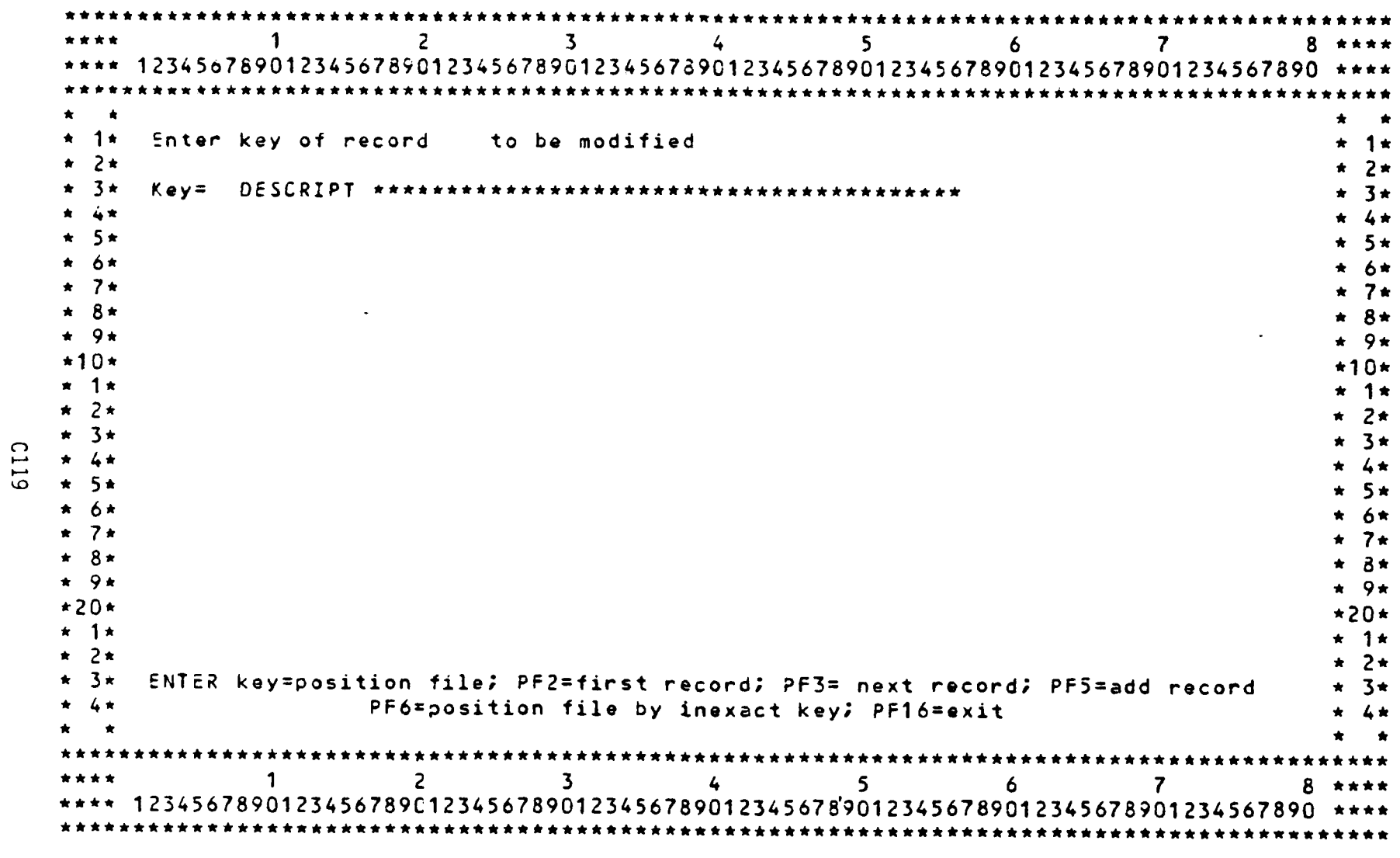


Fig 98. Data Entry Menu



C119

Fig 99. Modifications to Existing Project Data

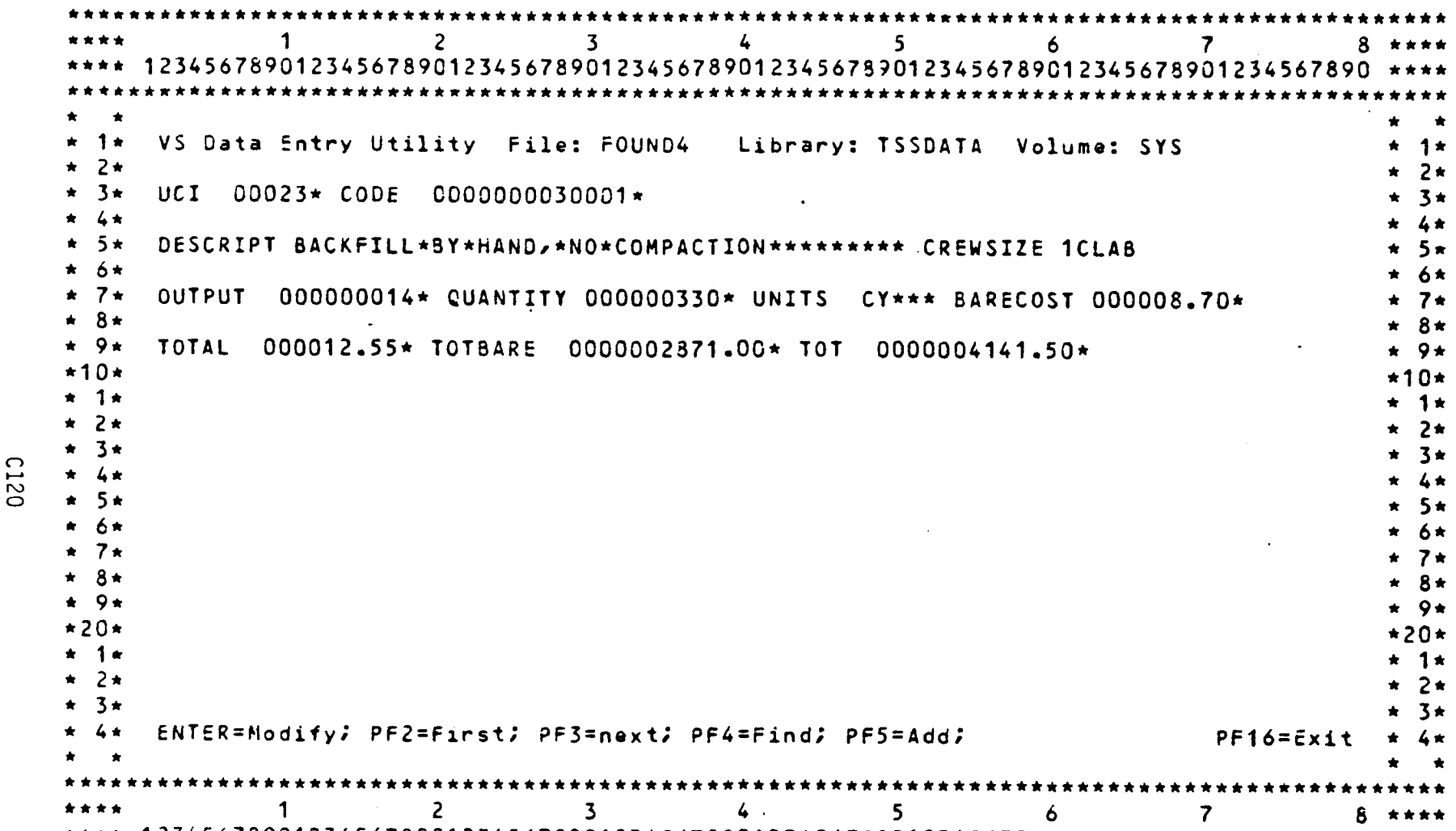


Fig 100. Example to be Modified

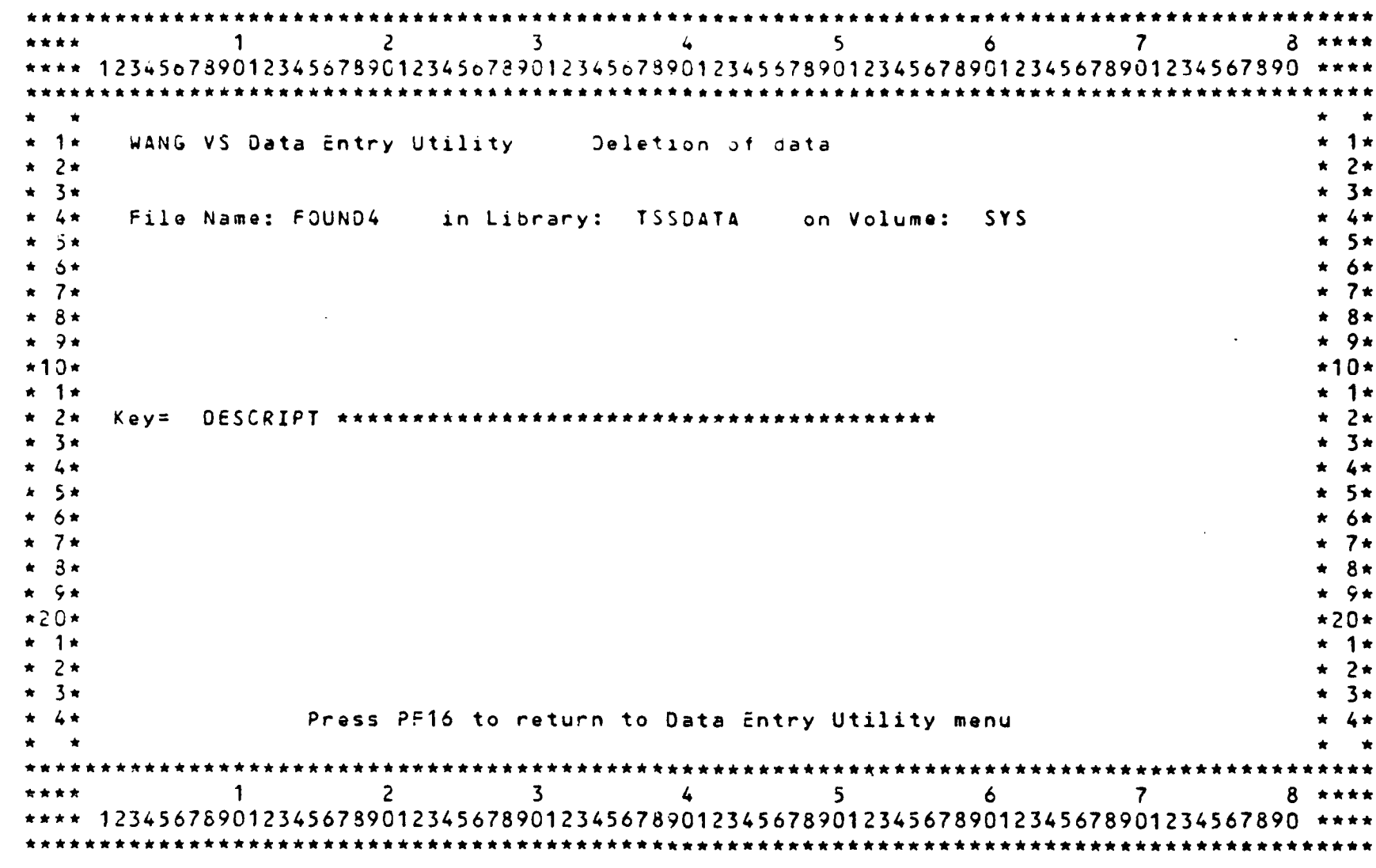


Fig 101. Deletion to Existing Project Data

Section III: EXPLANATION OF ESTIMATING PROGRAMS

Main Estimating Program

The main program prompts the user for several inputs and creates two project files for each design project. The ESTIMATE program is attached to this manual.

Running the ESTIMATE Program. The following steps are used when running the ESTIMATE program.

1. Complete the quantity take-off for the project and note the UCI CODE used to locate a particular item in the main data file.

2. Load the ESTIMATE program on the computer.

3. The first input item is shown in figure 102. Type in the items shown in figure 103 to complete the screen.

4. The next input item is "UCI MAJOR DIVISION CODE (###)=". Type in the UCI numbers used for the item in the main data file. Press "enter".

5. The next input item is "CODE SUB-DIVISION AND LINE NUMBER (########)=". Type in the numbers used for the item in the main data file.

6. The computer is now searching the main data file for the item. If the item cannot be found a message will appear reading "ITEM NOT FOUND IN DATA" "DO YOU WANT TO CHOOSE ANOTHER ITEM (Y OR N)=". To choose another item type in Y and repeat steps 3, 4, and 5. Type N to exit the program. If the item is found in the main data file a series of lines will appear on the monitor describing the item as shown in figure 107.

7. The next input indicates if the item found in the main data file is correct "IS ABOVE ITEM CORRECT (Y OR N)=". If the item is not correct type N and repeat steps 3, 4, and 5. If the item is correct type

Y and press "enter".

8. The next input prompts "DO YOU WISH TO WRITE DATA TO ANOTHER FILE (Y OR N) OR CONTINUE TO ADD TO AN EXISTING FILE (AD)=". The first item put in the project description file must be typed in as a Y, any additional items are typed in as AD. If a Y is used , the next screen shown in figure 108 appears. Type in the file name of the project and where the file is located in the library. If an AD is used the file name and library will already be inserted. Type in a N to exit the program.

9. The next screen shown in figure 106 shows what the existing file the data is being transferred from. This should be the same file as noted earlier in figure 103.

10. The next screen is verifing where the data is to be placed (figure 107). This should be the same file as noted earlier in figure 105.

11. The next input prompts "DO YOU WISH TO INSERT QUANTITIES (Y OR N) (QUANTITIES MUST BE ADDED AT THIS TIME FOR CALCULATIONS TO BE UPDATED)=". Type in a Y to continue or an N to exit the program. To add quantities into a project file a Y must be used.

12. The next input item is "WHAT IS YOUR QUANTITY FOR THIS ITEM=". Type in the estimated quantity and be sure the units of measure for the item in the main data file match the units of measure taken off the drawings. Type in numbers only.

13. The next input prompts "DO YOU WISH TO WRITE QUANTITIES TO ANOTHER FILE (Y OR N) OR CONTINUE TO ADD TO AN EXISTING FILE (AD)=". The first item put in the project quantity file must be typed in as a Y, any additional items are typed in as AD. If a Y is used, the next screen shown in figure 111 appears. Type in the file name of the project (different from the description file) and where the file is located in the library. If an AD is used the file name and library will automatically be

inserted by the computer. Type in a N to exit the program.

14. The next screen shown in figure 109 verifies where the data is placed.

15. The next prompt is "DO YOU WANT TO CONTINUE (Y OR N)=". Type a Y to repeat program for all items found in the project of type a N to exit the program.

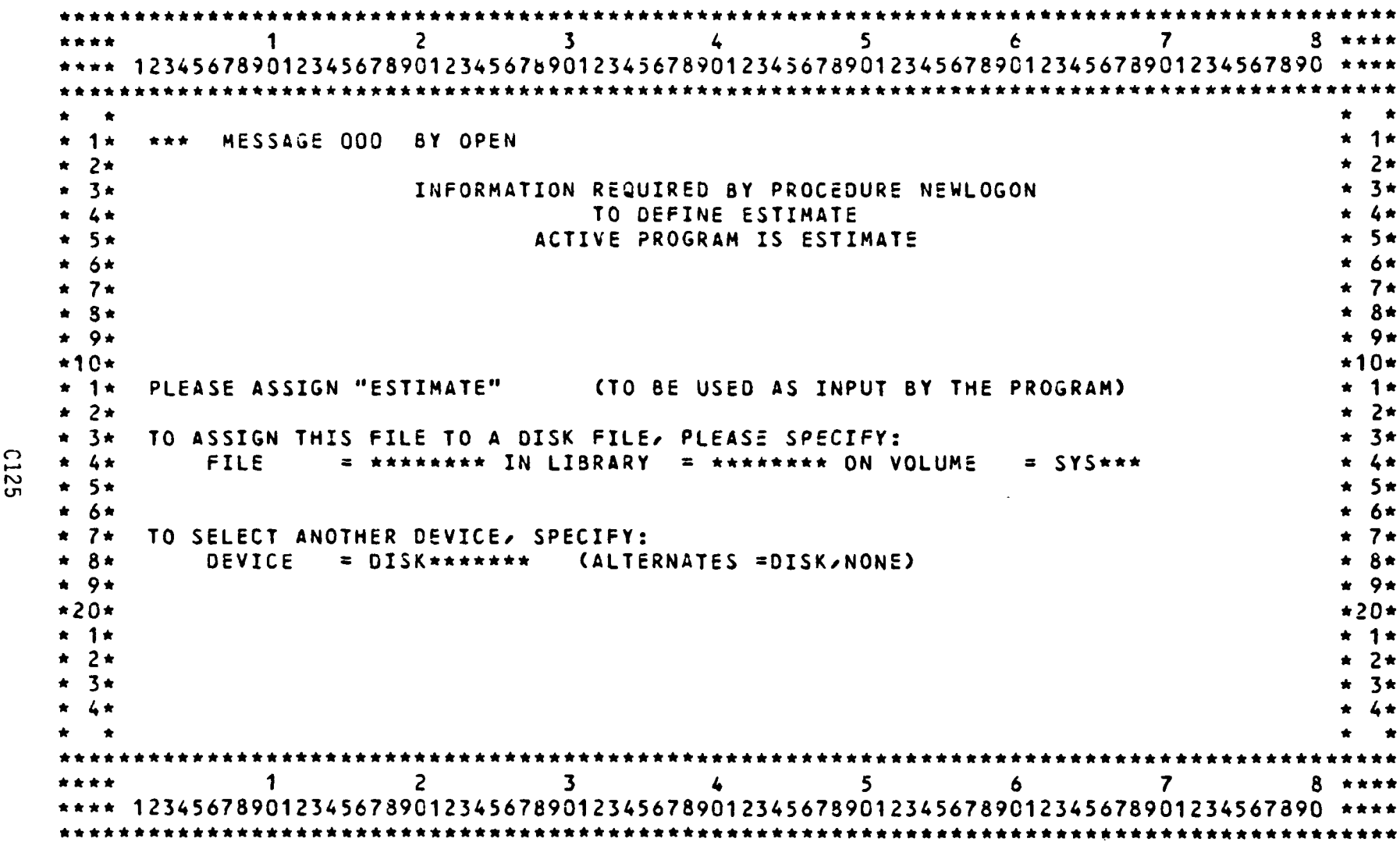
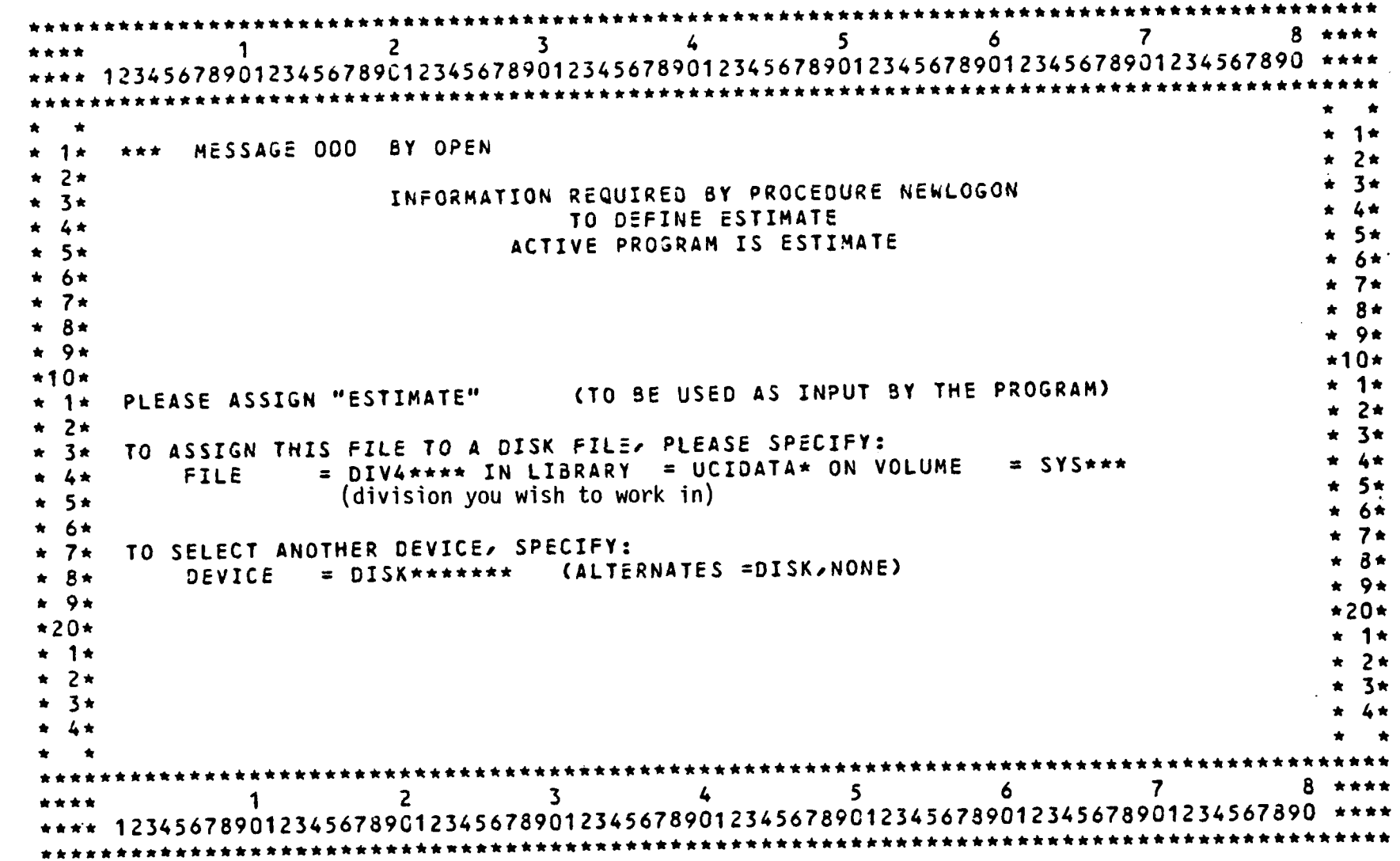


Fig 102. Input to Program



C126

Fig 103. Input to Program

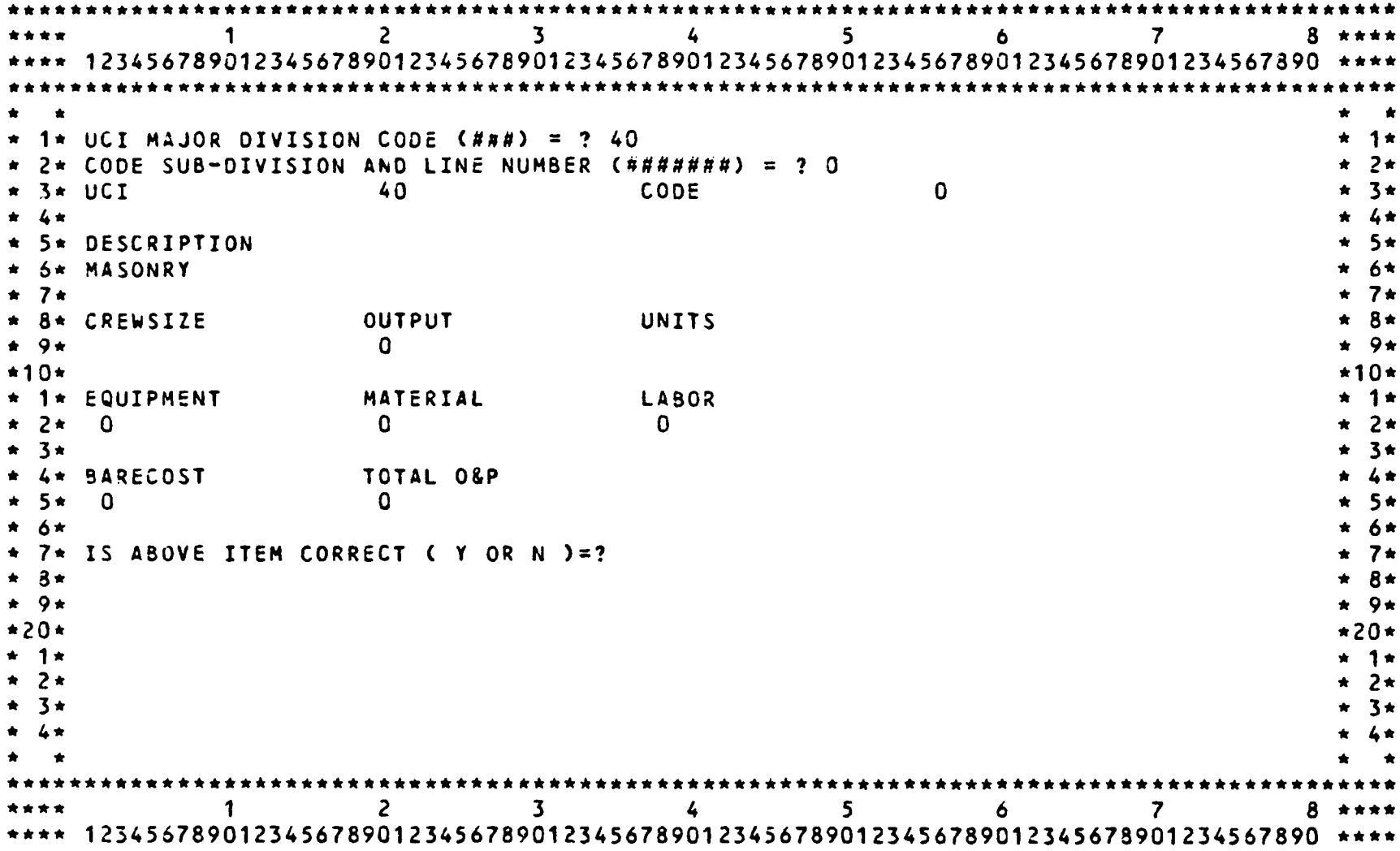


Fig 104. Item Found in Main Data Base

```
**********************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
**********************************************************************************
*  *                                                                             *  *
* 1*  ***  MESSAGE 000  BY OPEN                                                  * 1*
* 2*                                                                             * 2*
* 3*                    INFORMATION REQUIRED BY PROCEDURE NEWLOGON                * 3*
* 4*                                 TO DEFINE DESCRIPT                          * 4*
* 5*                           ACTIVE PROGRAM IS ESTIMATE                        * 5*
* 6*                                                                             * 6*
* 7*                                                                             * 7*
* 8*                                                                             * 8*
* 9*                                                                             * 9*
*10*                                                                             *10*
* 1*  PLEASE ASSIGN "DESCRIPT"      (TO BE CREATED AS OUTPUT BY THE PROGRAM)      * 1*
* 2*                                                                             * 2*
* 3*  TO ASSIGN THIS FILE TO A DISK FILE, PLEASE SPECIFY:                        * 3*
* 4*      FILE     = ******** IN LIBRARY  = ******** ON VOLUME   = SYS***        * 4*
* 5*      RECORDS  = *******     RETAIN   = *** DAYS    RELEASE  = YES           * 5*
* 6*      FILECLAS = $                                                           * 6*
* 7*                                                                             * 7*
* 8*      DEVICE   = DISK*******                                                 * 8*
* 9*                                                                             * 9*
*20*                                                                             *20*
* 1*                                                                             * 1*
* 2*                                                                             * 2*
* 3*                                                                             * 3*
* 4*                                                                             * 4*
*  *                                                                             *  *
**********************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
**********************************************************************************
```

C128

Fig 105. Assign Descript File

C129

Fig 106. Input to Program Verified

```
**********************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
**********************************************************************************
*  *                                                                             *  *
* 1*   ***  MESSAGE 000  BY OPEN                                                 * 1*
* 2*                                                                             * 2*
* 3*                      INFORMATION REQUIRED BY PROCEDURE NEWLOGON              * 3*
* 4*                                  TO DEFINE DESCRIPT                         * 4*
* 5*                             ACTIVE PROGRAM IS ESTIMATE                      * 5*
* 6*                                                                             * 6*
* 7*                                                                             * 7*
* 8*                                                                             * 8*
* 9*                                                                             * 9*
*10*                                                                             *10*
* 1*   PLEASE ASSIGN "DESCRIPT"       (TO BE UPDATED BY THE PROGRAM)             * 1*
* 2*                                                                             * 2*
* 3*   TO ASSIGN THIS FILE TO A DISK FILE, PLEASE SPECIFY:                       * 3*
* 4*       FILE     =           IN LIBRARY  = TSSDATA* ON VOLUME    = SYS***     * 4*
* 5*                                                                             * 5*
* 6*                                                                             * 6*
* 7*                                                                             * 7*
* 8*       DEVICE   = DISK*******                                                * 8*
* 9*                                                                             * 9*
*20*                                                                             *20*
* 1*                                                                             * 1*
* 2*                                                                             * 2*
* 3*                                                                             * 3*
* 4*                                                                             * 4*
*  *                                                                             *  *
**********************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
**********************************************************************************
```

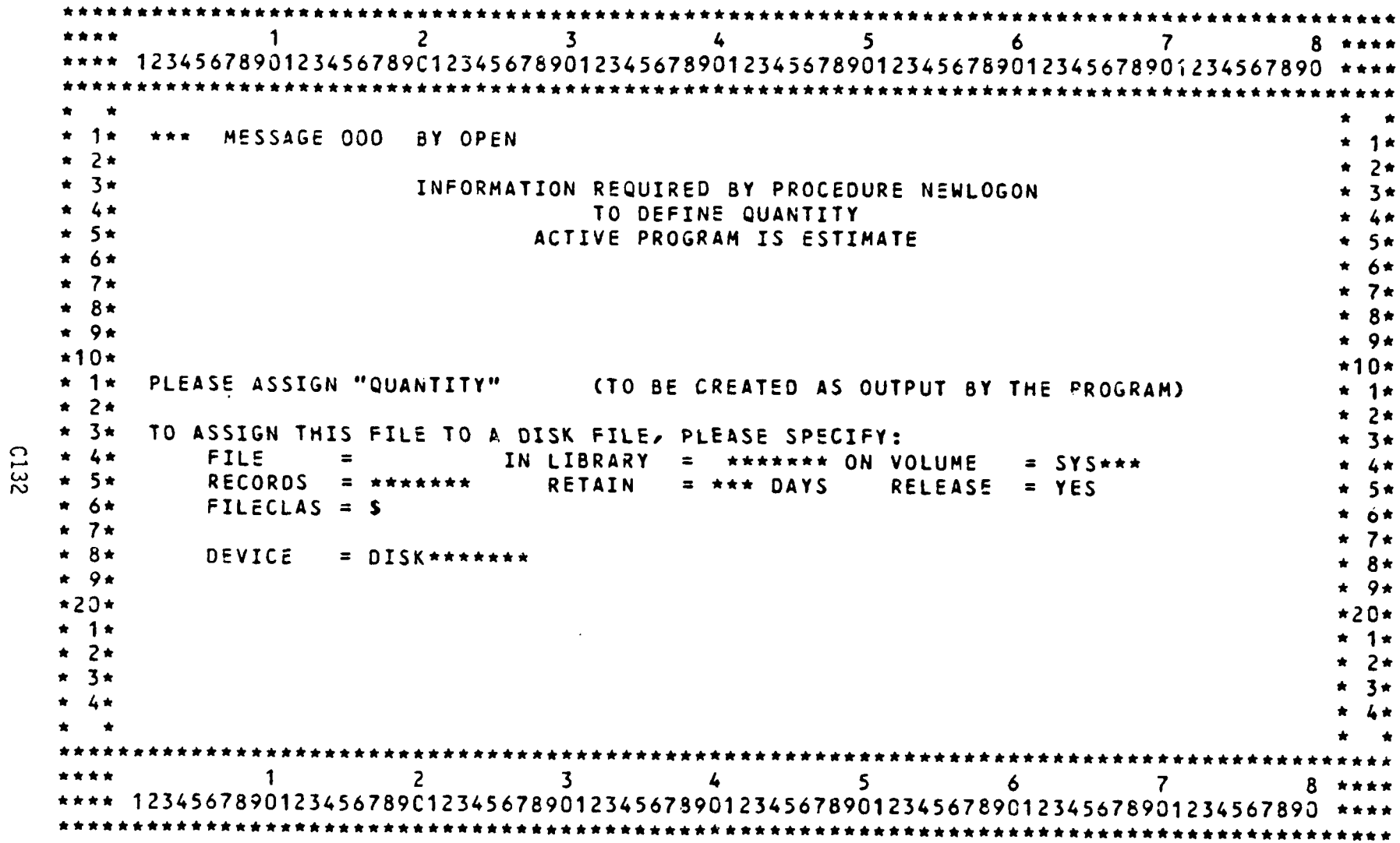
C130

Fig 107. Output of Description Verified

```
**********************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
**********************************************************************************
*  *                                                                             *  *
* 1*  ***  MESSAGE 000  BY OPEN                                                  * 1*
* 2*                                                                             * 2*
* 3*                    INFORMATION REQUIRED BY PROCEDURE NEWLOGON                * 3*
* 4*                                TO DEFINE QUANTITY                           * 4*
* 5*                          ACTIVE PROGRAM IS ESTIMATE                         * 5*
* 6*                                                                             * 6*
* 7*                                                                             * 7*
* 8*                                                                             * 8*
* 9*                                                                             * 9*
*10*                                                                             *10*
* 1*  PLEASE ASSIGN "QUANTITY"       (TO BE CREATED AS OUTPUT BY THE PROGRAM)     * 1*
* 2*                                                                             * 2*
* 3*  TO ASSIGN THIS FILE TO A DISK FILE, PLEASE SPECIFY:                        * 3*
* 4*      FILE     =          IN LIBRARY  =  ******* ON VOLUME   = SYS***         * 4*
* 5*      RECORDS  = *******     RETAIN   = *** DAYS    RELEASE  = YES           * 5*
* 6*      FILECLAS = $                                                           * 6*
* 7*                                                                             * 7*
* 8*      DEVICE   = DISK*******                                                 * 8*
* 9*                                                                             * 9*
*20*                                                                             *20*
* 1*                                                                             * 1*
* 2*                                                                             * 2*
* 3*                                                                             * 3*
* 4*                                                                             * 4*
*  *                                                                             *  *
**********************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
**********************************************************************************
```

C131

Fig 108. Assign Quantity File



C132

Fig 109. Output of Quantity Verified

Conversion of Project Files to Indexed Files

The INDEXDES and INDEXQNT programs use the project description file and the project quantity file respectively to create an index file for each. This enables additions, deletions, or modifications to the files without running the ESTIMATE program. The INDEXDES and INDEXQNT are located in the Appendix of this manual.

Running the INDEXDES Program. The following steps are used when running the INDEXDES program.

1. Load the INDEXDES program on the computer.

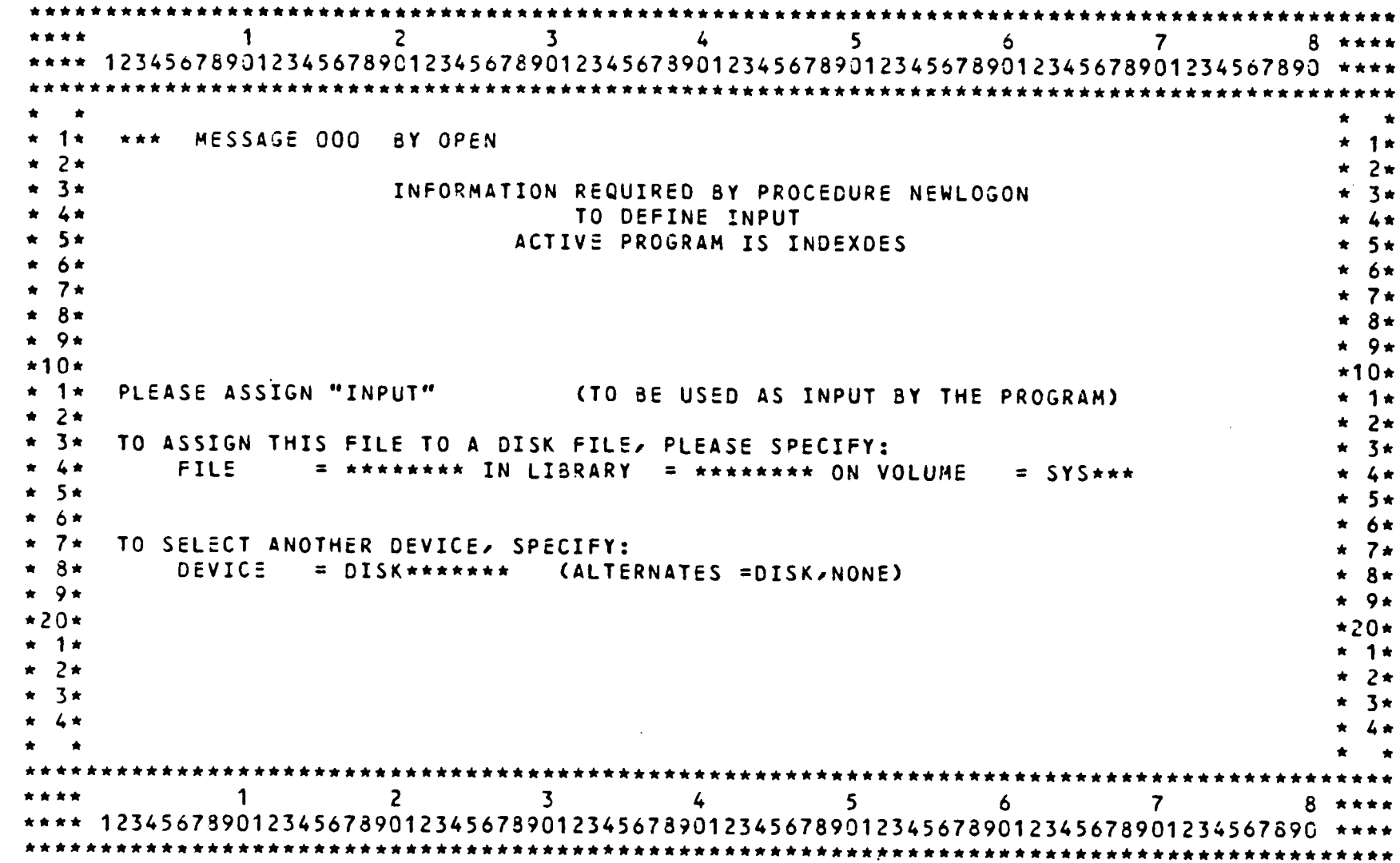
2. The first screen prompts the user to indicate where the input file is located (figure 110). Fill in the name of the project description file created during the ESTIMATE program.

3. The next screen prompts for the output file (figure 111). Type in the following: FILE = "file name", IN LIBRARY = "name library", RECORDS = "1 - 150".

4. The next screen verifies the output file (figure 112). This should be the same information as noted in figure 111.

5. After completing the program the screen shown in figure 113 appears. Press "enter" to exit the program.

Running the INDEXQNT Program. Follow the same steps noted above for the INDEXDES program.

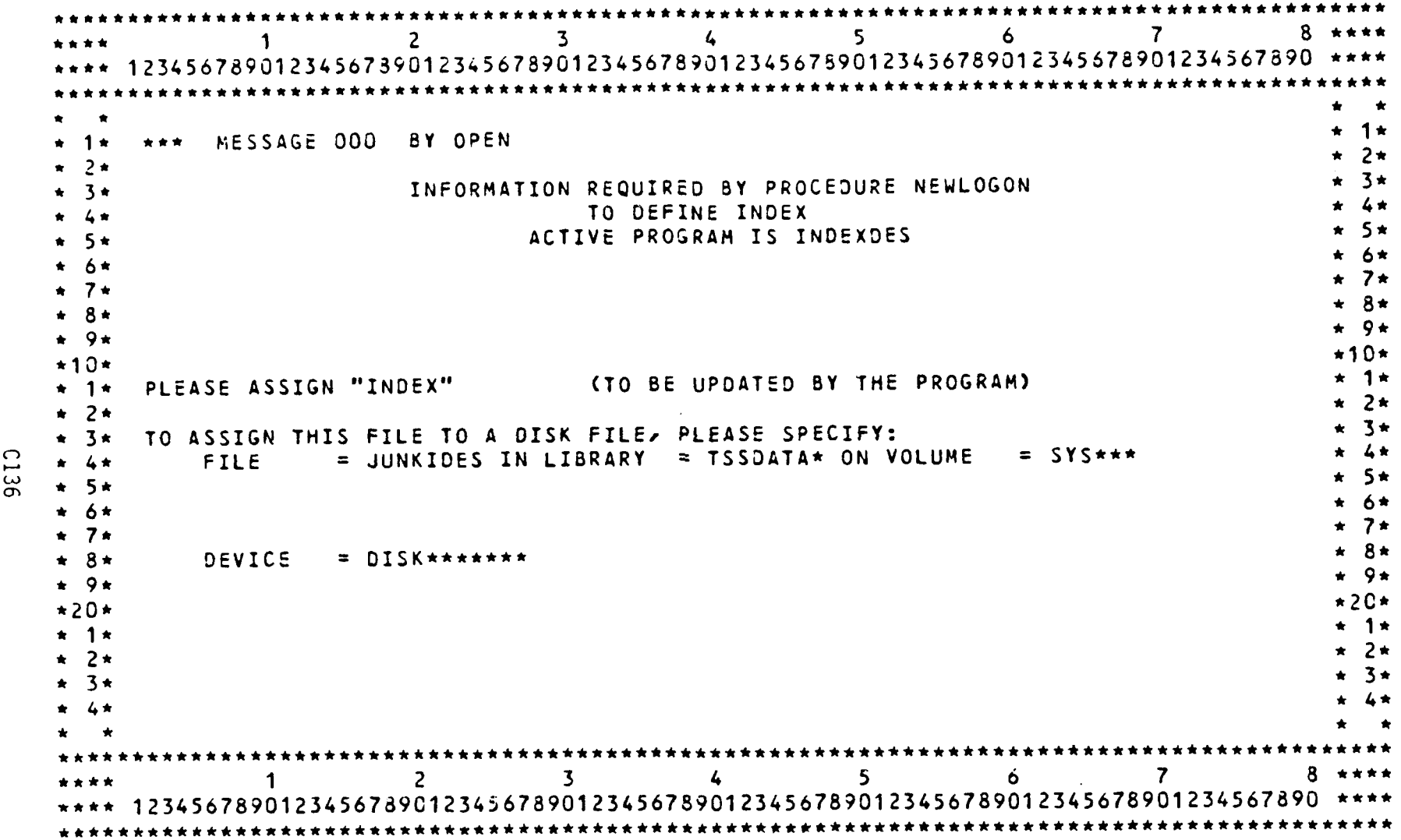


C134

Fig 110. Assign Description File as Input

```
*****************************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
*****************************************************************************************
*  *                                                                                    *  *
* 1*  ***  MESSAGE 000  BY OPEN                                                        * 1*
* 2*                                                                                    * 2*
* 3*                      INFORMATION REQUIRED BY PROCEDURE NEWLOGON                    * 3*
* 4*                                 TO DEFINE INDEX                                    * 4*
* 5*                            ACTIVE PROGRAM IS INDEXDES                              * 5*
* 6*                                                                                    * 6*
* 7*                                                                                    * 7*
* 8*                                                                                    * 8*
* 9*                                                                                    * 9*
*10*                                                                                    *10*
* 1*  PLEASE ASSIGN "INDEX"          (TO BE CREATED AS OUTPUT BY THE PROGRAM)          * 1*
* 2*                                                                                    * 2*
* 3*  TO ASSIGN THIS FILE TO A DISK FILE, PLEASE SPECIFY:                               * 3*
* 4*      FILE     = ******** IN LIBRARY  = ******** ON VOLUME   = SYS***               * 4*
* 5*      RECORDS  = *******     RETAIN   = *** DAYS    RELEASE  = NO*                 * 5*
* 6*      FILECLAS = $                                                                  * 6*
* 7*                                                                                    * 7*
* 8*      DEVICE   = DISK*******                                                        * 8*
* 9*                                                                                    * 9*
*20*                                                                                    *20*
* 1*                                                                                    * 1*
* 2*                                                                                    * 2*
* 3*                                                                                    * 3*
* 4*                                                                                    * 4*
*  *                                                                                    *  *
*****************************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
*****************************************************************************************
```

Fig 111. Assign Output File



C136

Fig 112. Output File Verified

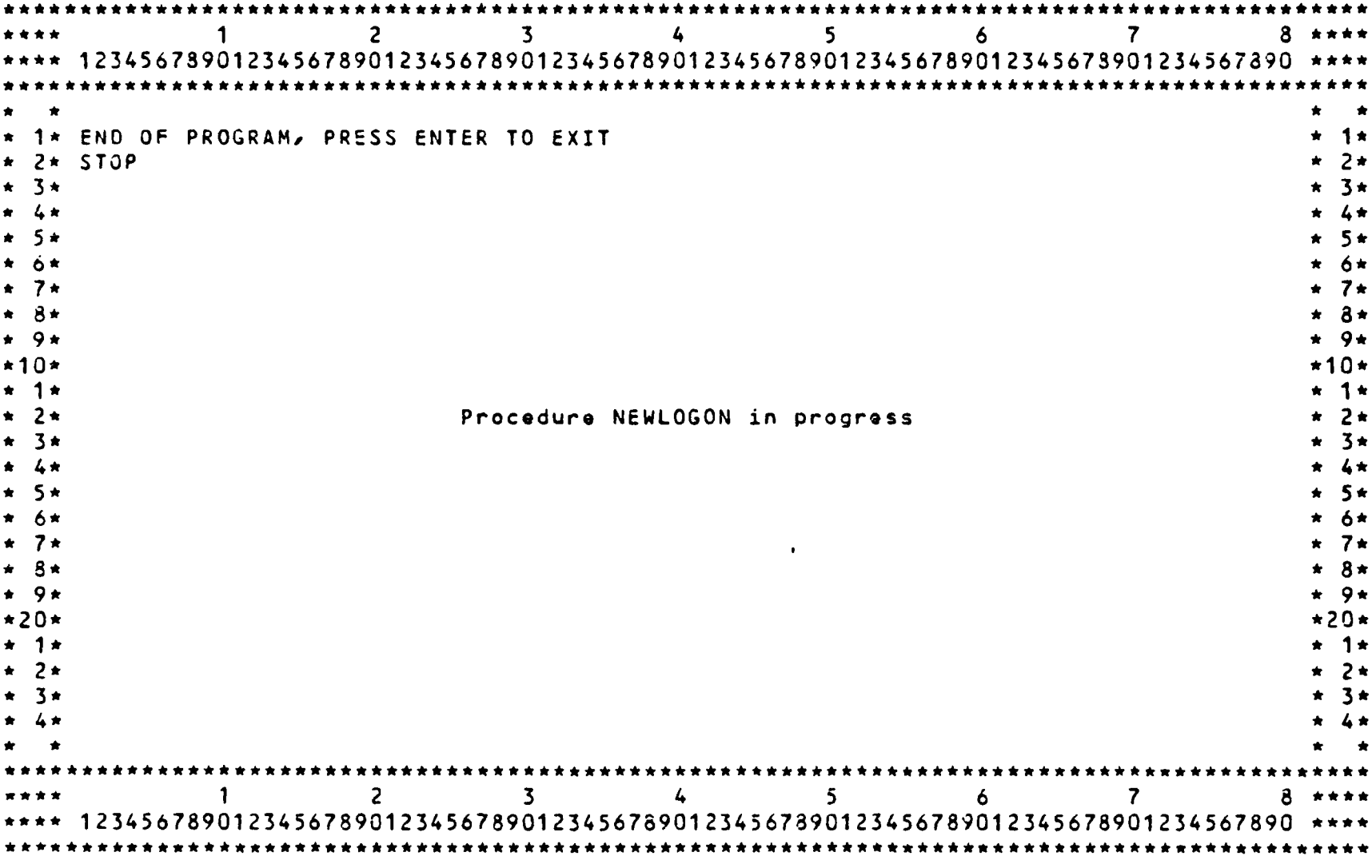


Fig 113. Program Complete

Sorting Files

If any additions or deletions to the project files are made a sort must be accomplished before running the report programs. A sort will put all the records in a file in a particular order. For example, when adding a record to the project file that record is added at the end of the file. The report program keys on records in sequence and a sort will put all records in sequence.

Running the SORT Procedure.

1. Logon the the system using standard procedures.

2. The logon menu indicating the PF key for User Program is now on the monitor. Press the PF key opposite User Program, in thes example it's PF key 12 (figure 114).

3. The user program screen shown in figure 115 is now on the monitor. Type in PROGRAM = SORT and press "enter" to continue.

4. The next screen shown in figure 116 prompts for the function. Type in FUNCTION = SORT and press "enter".

5. The input to the sort function is now typed in. Type in the name of the file and the library of the file to be sorted in the places shown in figure 117 and press "enter".

6. The next screen now prompts for the sort keys (figure 118). Complete the screen as shown in figure 119 and press "enter".

7. The next screen now prompts for the output file. Type in the new name of the file to be created and the library in the places shown in figure 120. Press "enter" to continue.

8. The next screen shown in figure 121 will appear on the monitor. In the lower left corner is a message indicating the sort program was completed.

9. Press PF key 16 to logoff the system.

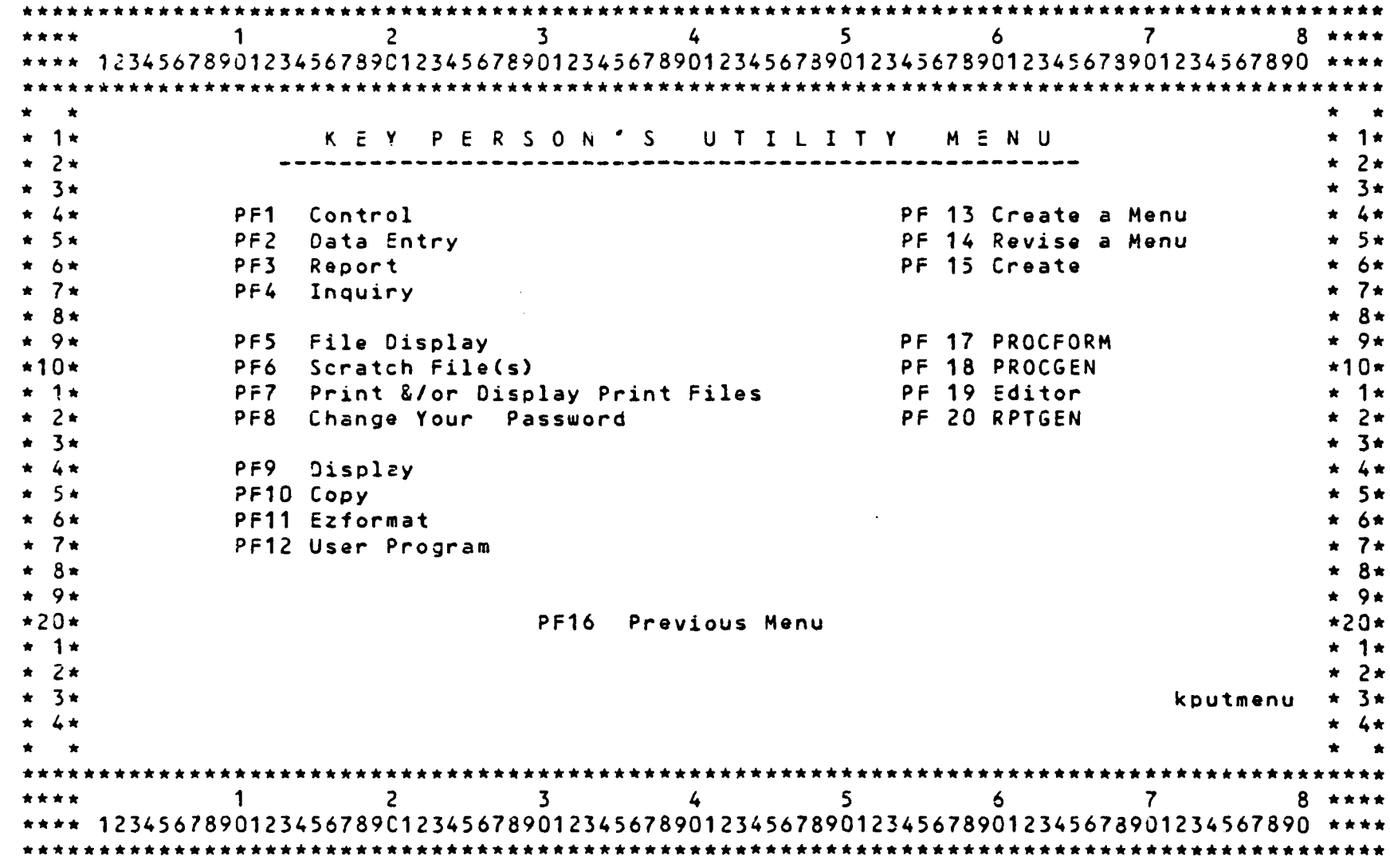


Fig 114. Utility Menu

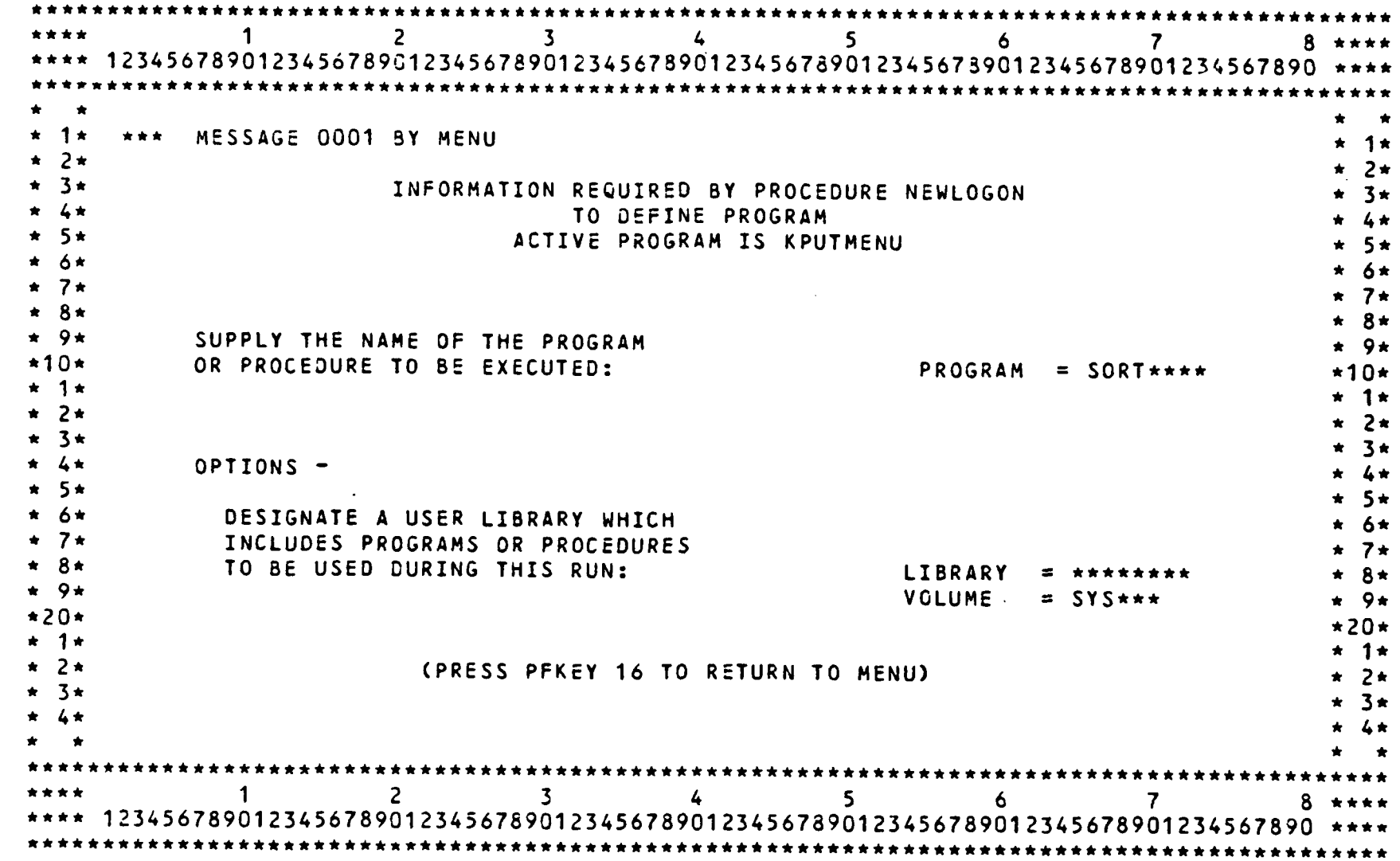
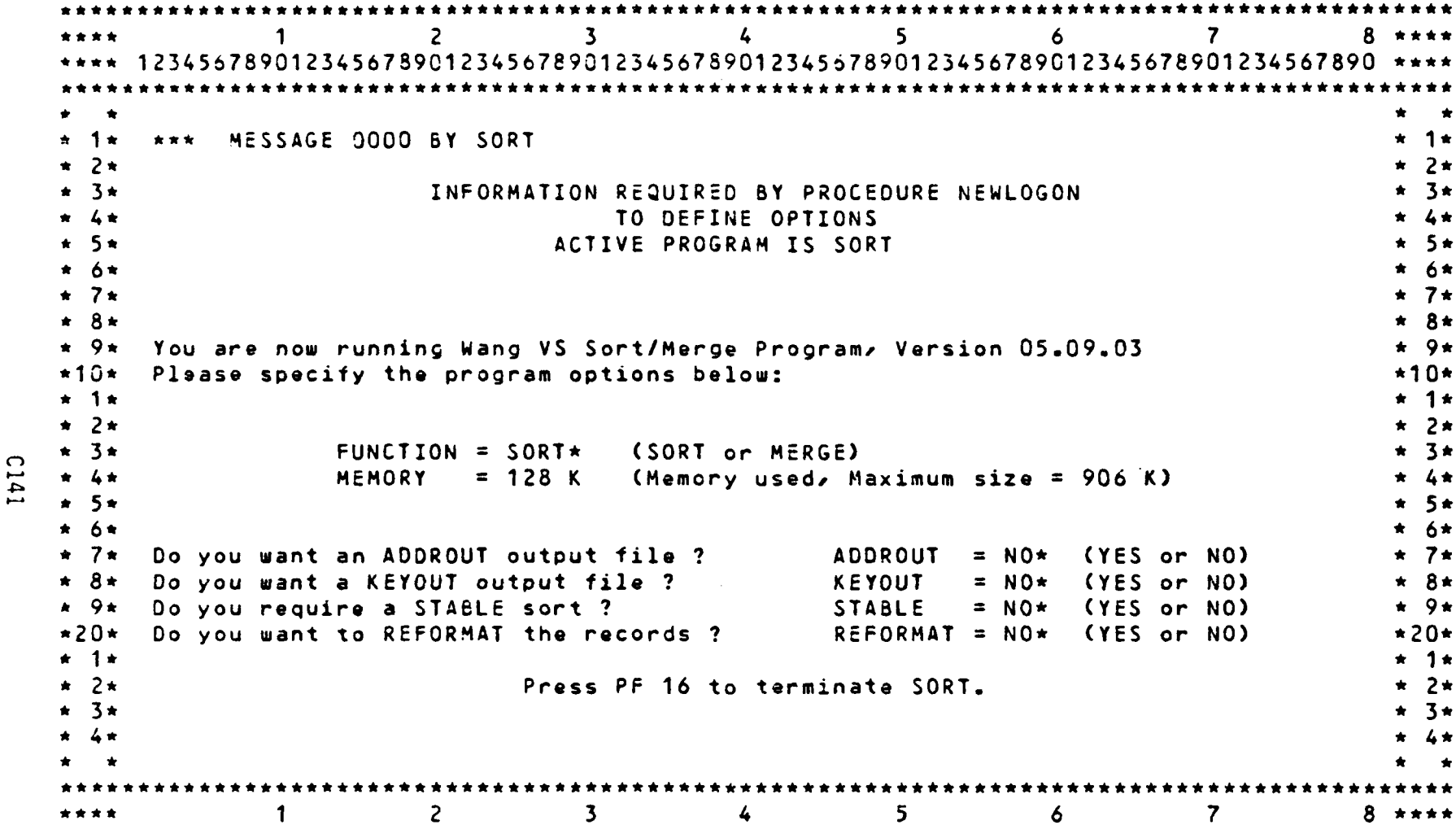


Fig 115. User Program Screen



C141

Fig 116. Sort Function

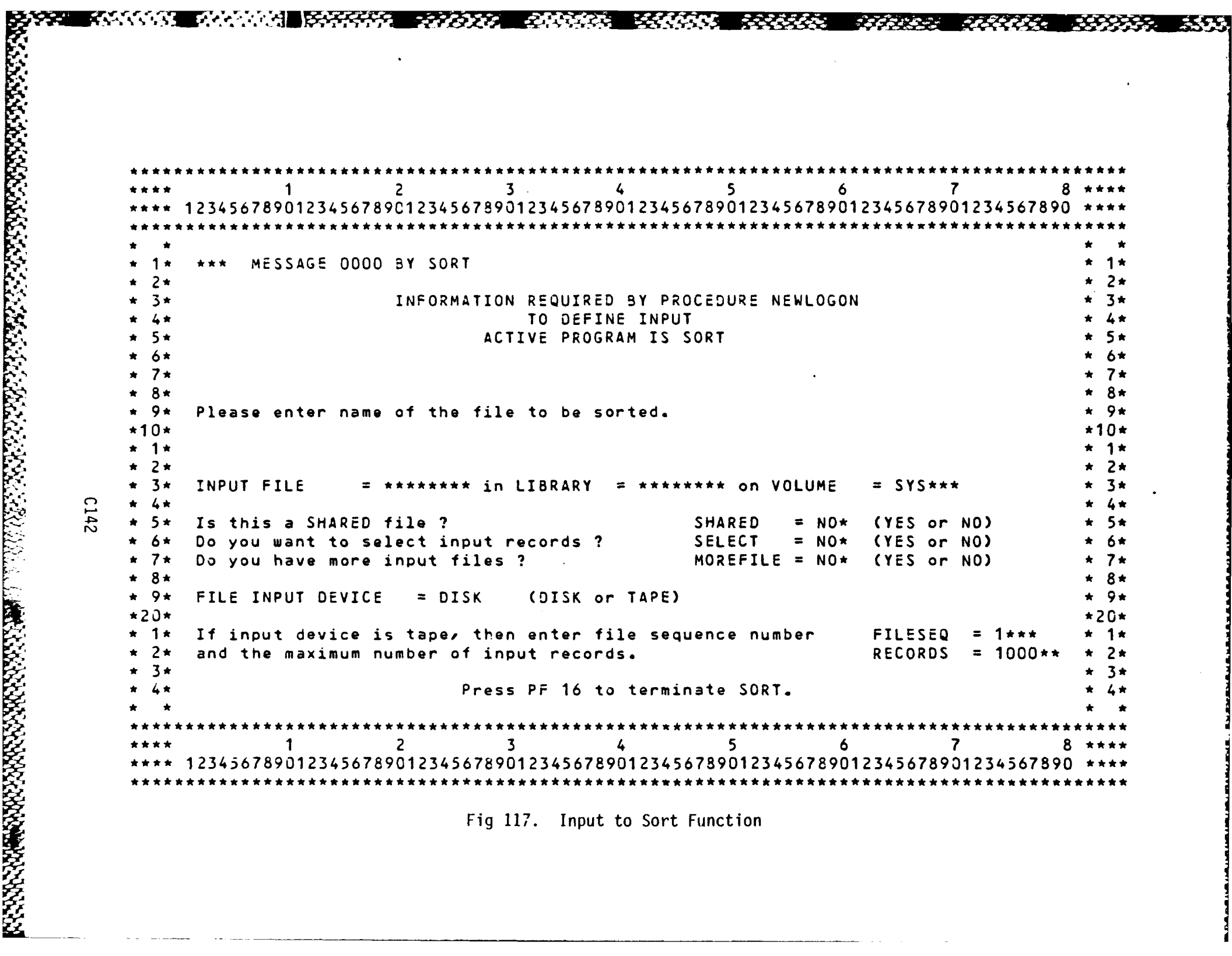


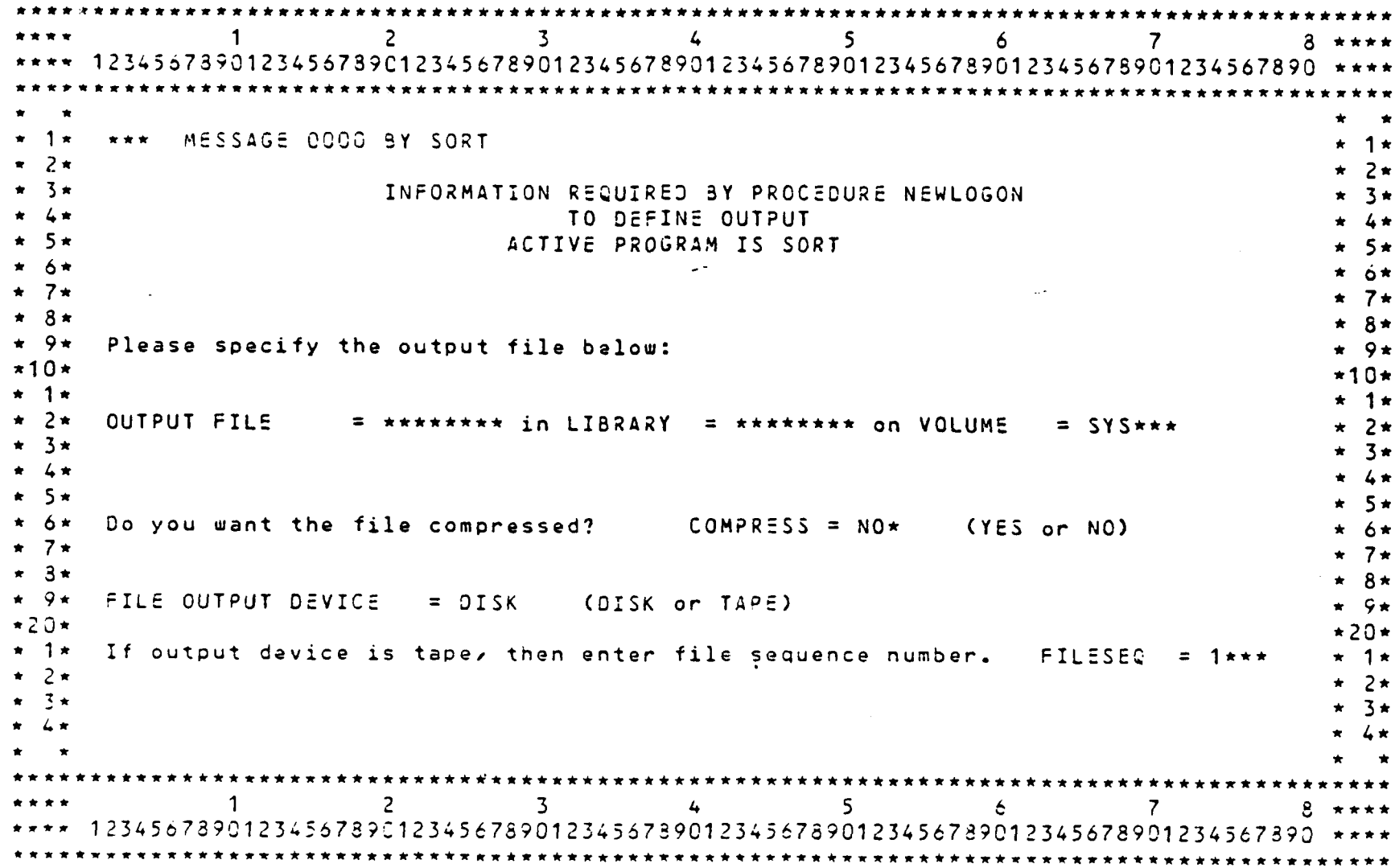
Fig 117. Input to Sort Function

```
*****************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
*****************************************************************************
*  *                                                                        *  *
* 1*  ***  MESSAGE 0001 BY SORT                                            * 1*
* 2*                                                                        * 2*
* 3*                    INFORMATION REQUIRED BY PROCEDURE NEWLOGON          * 3*
* 4*                                 TO DEFINE KEYS                         * 4*
* 5*                            ACTIVE PROGRAM IS SORT                      * 5*
* 6*                                                                        * 6*
* 7*  Please specify Sort/Merge keys:                                       * 7*
* 8*                                                                        * 8*
* 9*  NUMBER OF KEYS      = 1  (Less than or equal to 8)                    * 9*
*10*  Key attributes:                                                       *10*
* 1*            Position(>0)      Length in Bytes  Sort Key Type   Sort Order(A,D)     * 1*
* 2*  Key 1:   POST1    = ****  LENGTH1  = ***   TYPE1    = C    ORDER1   = A        * 2*
* 3*  Key 2:   POST2    = ****  LENGTH2  = ***   TYPE2    = C    ORDER2   = A        * 3*
* 4*  Key 3:   POST3    = ****  LENGTH3  = ***   TYPE3    = C    ORDER3   = A        * 4*
* 5*  Key 4:   POST4    = ****  LENGTH4  = ***   TYPE4    = C    ORDER4   = A        * 5*
* 6*  Key 5:   POST5    = ****  LENGTH5  = ***   TYPE5    = C    ORDER5   = A        * 6*
* 7*  Key 6:   POST6    = ****  LENGTH6  = ***   TYPE6    = C    ORDER6   = A        * 7*
* 8*  Key 7:   POST7    = ****  LENGTH7  = ***   TYPE7    = C    ORDER7   = A        * 8*
* 9*  Key 8:   POST8    = ****  LENGTH8  = ***   TYPE8    = C    ORDER8   = A        * 9*
*20*                                                                       *20*
* 1*  * Key Type:    B=Binary, C=Character, D=Decimal, F=Floating, P=Packed  * 1*
* 2*                 Z=Zoned decimal, L=Zoned decimal sign leading           * 2*
* 3*  * Sort Order:  A=Ascending, D=Descending                               * 3*
* 4*                                                                        * 4*
*  *                                                                        *  *
*****************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
*****************************************************************************
```

Fig 118. Sort Keys

```
**********************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
**********************************************************************************
*  *                                                                             *  *
* 1*  ***  MESSAGE 0001 BY SORT                                                  * 1*
* 2*                                                                             * 2*
* 3*                    INFORMATION REQUIRED BY PROCEDURE NEWLOGON                * 3*
* 4*                                TO DEFINE KEYS                               * 4*
* 5*                           ACTIVE PROGRAM IS SORT                            * 5*
* 6*                                                                             * 6*
* 7*  Please specify Sort/Merge keys:                                            * 7*
* 8*                                                                             * 8*
* 9*  NUMBER OF KEYS      = 2  (Less than or equal to 8)                         * 9*
*10*  Key attributes:                                                            *10*
* 1*           Position(>0)      Length in Bytes  Sort Key Type   Sort Order(A,D)  * 1*
* 2*  Key 1:   POST1    = 1***  LENGTH1  = 3**   TYPE1    = P    ORDER1   = A     * 2*
* 3*  Key 2:   POST2    = 4***  LENGTH2  = 7**   TYPE2    = P    ORDER2   = A     * 3*
* 4*  Key 3:   POST3    = ****  LENGTH3  = ***   TYPE3    = C    ORDER3   = A     * 4*
* 5*  Key 4:   POST4    = ****  LENGTH4  = ***   TYPE4    = C    ORDER4   = A     * 5*
* 6*  Key 5:   POST5    = ****  LENGTH5  = ***   TYPE5    = C    ORDER5   = A     * 6*
* 7*  Key 6:   POST6    = ****  LENGTH6  = ***   TYPE6    = C    ORDER6   = A     * 7*
* 8*  Key 7:   POST7    = ****  LENGTH7  = ***   TYPE7    = C    ORDER7   = A     * 8*
* 9*  Key 8:   POST8    = ****  LENGTH8  = ***   TYPE8    = C    ORDER8   = A     * 9*
*20*                                                                             *2C*
* 1*  * Key Type:    B=Binary, C=Character, D=Decimal, F=Floating, P=Packed       * 1*
* 2*                 Z=Zoned decimal, L=Zoned decimal sign leading               * 2*
* 3*  * Sort Order:  A=Ascending, D=Descending                                    * 3*
* 4*                                                                             * 4*
*  *                                                                             *  *
**********************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
**********************************************************************************
```

Fig 119. Sort Keys



C145

Fig 120. Output of Sort Function

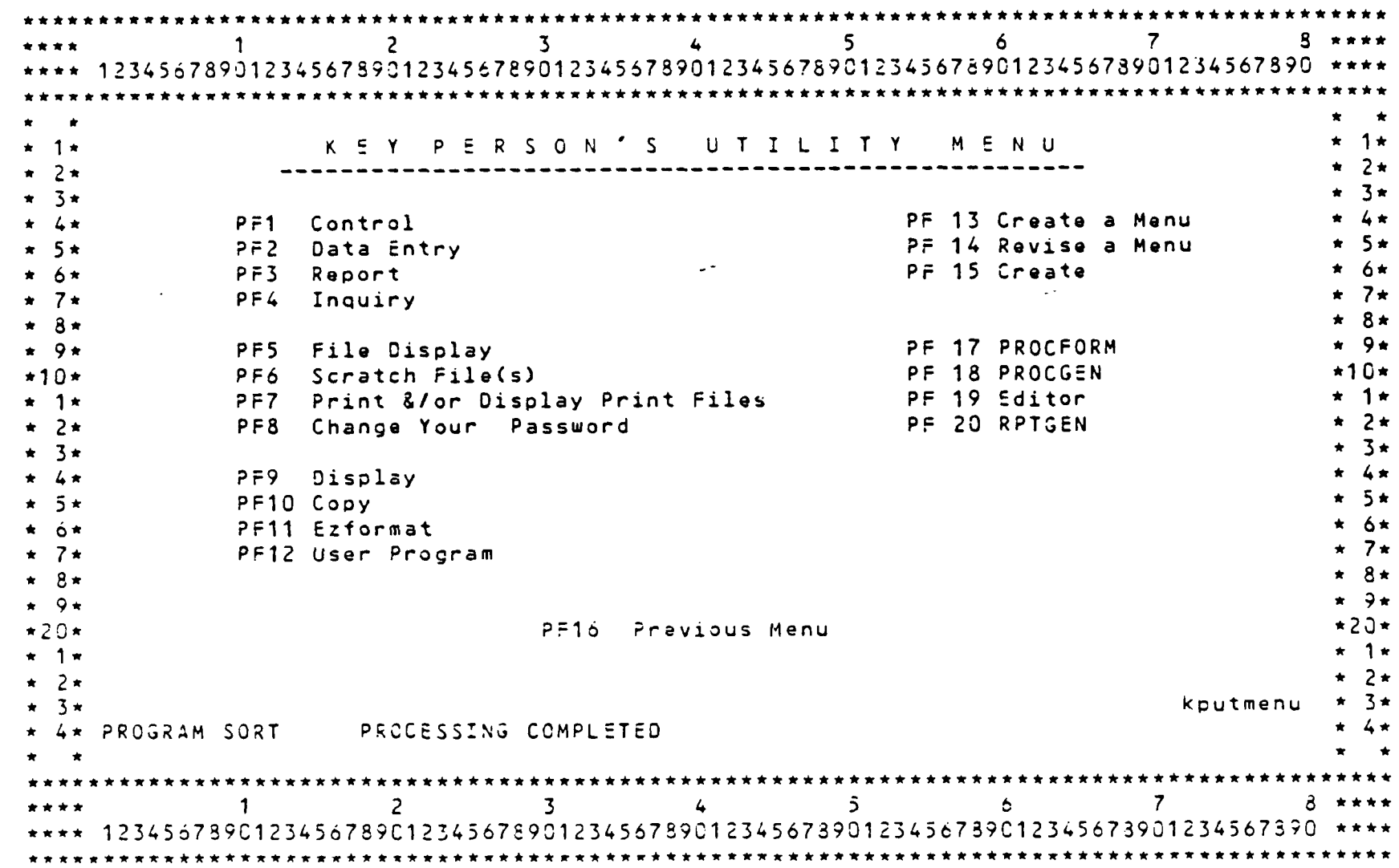


Fig 121. Utility Menu

Running a Report on Project Files

The DESCRIPT and QUANTITY programs use the sorted files produced during the SORT procedure. Each report has different information. A sample of each report is shown in figures 122 thre 124. The DESCRIPT and QUANTITY programs are located in the Appendix of this manual.

Running the DESCRIPT Program. The following steps are used when running the DESCRIPT program.

1. Load DESCRIPT program on the computer.

2. The first screen to appear will prompt for the input file (figure 125). Type in the name of the file to be printed and the library it is located in and press "enter".

3. The next screen shown in figure 126 is verifing the input file. The items should be the same as noted in step 2. Press "enter to continue.

4. The program will prompt for the project name next. Limit the project name to 30 characters and press "enter".

5. The program now prompts for the project number. Limit the project number to 15 characters and press "enter".

6. The program is now generating a description report similar to figure 122. The report is automatically sent to the printer. When the program is finished a prompt will appear indicating "end of program", press "enter" to exit the program.

Running the QUANTITY Program. The following steps are used when running the QUANTITY program.

1. Load the QUANTITY program on the computer.

2. Follow steps 2 - 6 of the DESCRIPT program.

3. In addition to the quantity report a project summary page is printed last. The items shown on the monitor (figure 127) indicate the

factors and the default values if nothing is changed. If the factors are modified type in a "Y" and press "enter". If no change is needed type a "N" and press "enter".

4. If a "Y" was used in step 3 all the factors must have a value typed in after each prompt and press "enter" (see figure 128). Type in the decimal equivalent of the percentage used.

5. After all factors are modified or after a "N" was typed in step 3 a prompt will appear on the screen indicating if more factors wish to be added. Type in a "Y" for yes and a "N" for no (see figure 128).

6. If more factors are needed the program will prompt for the name of the factor (limmit to 30 characters) and the percent of the factor. Enter the decimal equivalent of the percentage and continue. A possibility of four additional factors can be added in this section (see figure 129).

7. The project summary is automatically sent to the printer. When the program is complete a message will appear indicating "end of program". A sample project summary report is shown in figure 124.

PROJECT NAME: FOUNDATION HOMEWORK
PROJECT NUMBER: MPAPS #XXXXX

DESCRIPTION REPORT

UCI	CODE	DESCRIPTION	CREW	OUTPUT	UNITS	EQUIP	MATL	LABOR	BARECOST	TOTAL O&P
10	0	GENERAL REQUIREMENTS		0		0.00	0.00	0.00	0.00	0.00
20	0	SITEWORK		0		0.00	0.00	0.00	0.00	0.00
23	10001	BACKFILL BY HAND, NO COMPACTION	1CLAB	14	CY	0.00	0.00	6.70	6.70	12.55
23	30110	BACKFILL BY HAND, VIB. PLATE 12", ADD	A-1	90	CY	.39	0.00	1.36	1.75	2.35
23	180005	TRENCH EXCAVATING 4' WIDE, 4' DEEP	B-11C	150	CY	1.01	0.00	1.36	2.37	3.80
23	200060	GRAVEL FILL, COMPACTED, UNDER SLAB, 6"	B-14	9000	SF	0.00	.12	.10	.22	.27
30	0	CONCRETE		0		0.00	0.00	0.00	0.00	0.00
31	100200	EXP. JT. PREMOLDED BITU. FIBER 1/2" X 6"	1CARP	375	LF	0.00	.40	.41	.81	1.03
32	60001	WELDED WIRE FABRIC, 6 X 6 - #10/10	2RODM	35	CSF	0.00	7.65	9.50	17.15	23.00
33	120020	CONCRETE, READY MIX REG. WT., 3500 PSI		0	CY	0.00	46.25	0.00	0.00	51.00
33	140395	CONC. IN PLACE, STRIP FOOTINGS 36" X 12"	C-17B	51	CY	0.00	51.00	35.00	86.00	105.00
33	160030	CURING CONC. WITH SPRAYED COMPOUND	2CLAB	95	CSF	0.00	1.50	2.57	4.07	5.35
33	260001	FINISH FLOOR, MONOLITHIC SCREED FINISH	1CEFI	900	SF	0.00	0.00	.17	.17	.23
33	380430	PLACING CONC. SLAB 4" THICK, DIRECT	C-6	110	CY	.45	0.00	7.05	7.50	10.60
40	0	MASONRY		0		0.00	0.00	0.00	0.00	0.00
43	50041	CONC BLOCK FOUND., 8" X 16" BLK., 6" THK	D-3	450	SF	0.00	1.05	1.70	2.75	3.56
43	50042	CONC BLOCK FOUND. 8" X 16" BLK., 8" THK	D-3	430	SF	0.00	1.30	1.78	3.08	3.95
43	50346	BOND BEAM INCL.GROUT & 2 #5 BARS, 8"X8"	D-3	300	LF	0.00	1.95	2.54	4.49	5.75
70	0	MOISTURE AND THERMAL PROTECTION		0		0.00	0.00	0.00	0.00	0.00
71	100005	BIT. COATING FOUNDATION, BRUSH 1 COAT	1FOFC	665	SF	0.00	.08	.22	.30	.42
71	150070	POLYETHYLENE VAPOR BARRIER, .004" THICK	1CARP	37	SQ	0.00	5.00	4.16	9.16	11.50
72	300070	PERIMETER INSUL. POLYSTYRENE 2" R8	1CARP	675	SF	0.00	.38	.23	.61	.75
76	250980	FLASHING, ZINC & COPPER, .032" THICK	1SMEE	155	SF	0.00	1.60	1.12	2.72	3.39

Fig 122. Description Report

PROJECT NAME: FOUNDATION HOMEWORK
PROJECT NUMBER: #PAFB ENG40C

QUANTITY TAKE-OFF REPORT

UCI CODE	DESCRIPTION	CREW SIZE	DAILY OUTPUT	QUANTITY	UNITS	BARE UNIT COSTS	TOTAL UNIT INC. O & P	TOTAL BARE COSTS	TOTAL COSTS INC. O & P
10 0	GENERAL REQUIREMENTS		0	0		0.00	0.00	0.00	0.00
TOTAL DIVISION COSTS								0.00	0.00
20 0	SITE WORK		0	0		0.00	0.00	0.00	0.00
23 30001	BACKFILL BY HAND, NO COMPACTION	1CLAB	14	330	CY	8.70	12.55	2871.00	4141.50
23 30110	BACKFILL BY HAND, VIB. PLATE 12", ADD	A-1	90	330	CY	1.75	2.38	577.50	785.40
23 180005	TRENCH EXCAVATING 4' WIDE, 4' DEEP	B-11C	150	360	CY	2.87	3.50	1033.20	1368.00
23 200060	GRAVEL FILL, COMPACTED, UNDER SLAB, 6"	B-14	9000	4000	SF	.22	.27	880.00	1080.00
TOTAL DIVISION COSTS								5361.70	7374.90
30 0	CONCRETE		0	0		0.00	0.00	0.00	0.00
31 100200	EXP. JT. PREMOLDED BITU. FIBER 1/2" X 6"	1CARP	375	280	LF	.81	1.03	226.80	288.40
32 60001	WELDED WIRE FABRIC, 6 X 6 - #10/10	2RODM	35	40	CSF	17.15	23.00	686.00	920.00
33 120020	CONCRETE, READY MIX REG. WT., 3500 PSI		0	50	CY	0.00	51.00	0.00	2550.00
33 140395	CONC. IN PLACE, STRIP FOOTINGS 36" X 12"	C-17B	51	23	CY	86.00	105.00	1978.00	2415.00
33 160030	CURING CONC. WITH SPRAYED COMPOUND	2CLAB	95	40	CSF	4.07	5.35	162.80	214.00
33 260001	FINISH FLOOR, MONOLITHIC SCREED FINISH	1CEMI	900	4000	SF	.17	.23	680.00	920.00
33 330430	PLACING CONC. SLAB 4" THICK, DIRECT	C-6	110	30	CY	7.50	10.60	378.00	530.00
TOTAL DIVISION COSTS								4108.80	7107.40

C150

Fig 123. Quantity Take-Off Report

PROJECT NAME: FOUNDATION HOMEWORK
PROJECT NUMBER: WPAFB 86-00

****

PROJECT SUMMARY

****

SPECIFICATION DIVISION		TOTAL BARE COSTS	
DIVISION 1 GENERAL CONDITIONS		0.00	
DIVISION 2 SITE WORK		5061.70	
DIVISION 3 CONCRETE		4108.80	
DIVISION 4 MASONRY		5036.25	
DIVISION 5 METALS		0.00	
DIVISION 6 WOOD & PLASTICS		0.00	
DIVISION 7 MOISTURE & THERMAL PROTE		1879.80	
DIVISION 8 DOORS, WINDOWS & GLASS		0.00	
DIVISION 9 FINISHES		0.00	
DIVISION 10 SPECIALTIES		0.00	
DIVISION 11 EQUIPMENT		0.00	
DIVISION 12 FURNISHINGS		0.00	
DIVISION 13 SPECIAL CONSTRUCTION		0.00	
DIVISION 14 CONVEYING SYSTEMS		0.00	
DIVISION 15 MECHANICAL		0.00	
DIVISION 16 ELECTRICAL		0.00	
TOTAL BARE COSTS		16136.15	16136.15
OVERHEAD/PROFIT FACTORS			
OVERHEAD FOR GENERAL CONTRACTOR	.2500	4046.53	
PERFORMANCE BOND ($5/THOUSAND)	12.0000	194.23	
WORKER'S COMPENSATION	.0403	376.96	
BUILDERS RISK & PUBLIC LIA. INS.	.0120	116.94	
SOCIAL SECURITY TAX	.0770	747.80	
UNEMPLOYMENT TAX	.0360	349.62	
MATERIAL TAX	.0400	388.46	
PROFIT	.0500	809.30	
TOTAL OVERHEAD/PROFIT		7529.47	7529.47
OTHER FACTORS			
SUB CONTRACTOR FOR DIV 3	.0500	809.00	
NONE	0.0000	0.00	
NONE	0.0000	0.00	
NONE	0.0000	0.00	
TOTAL ADDITIONAL FACTORS		809.00	809.00
TOTAL PROJECT COSTS			24474.62

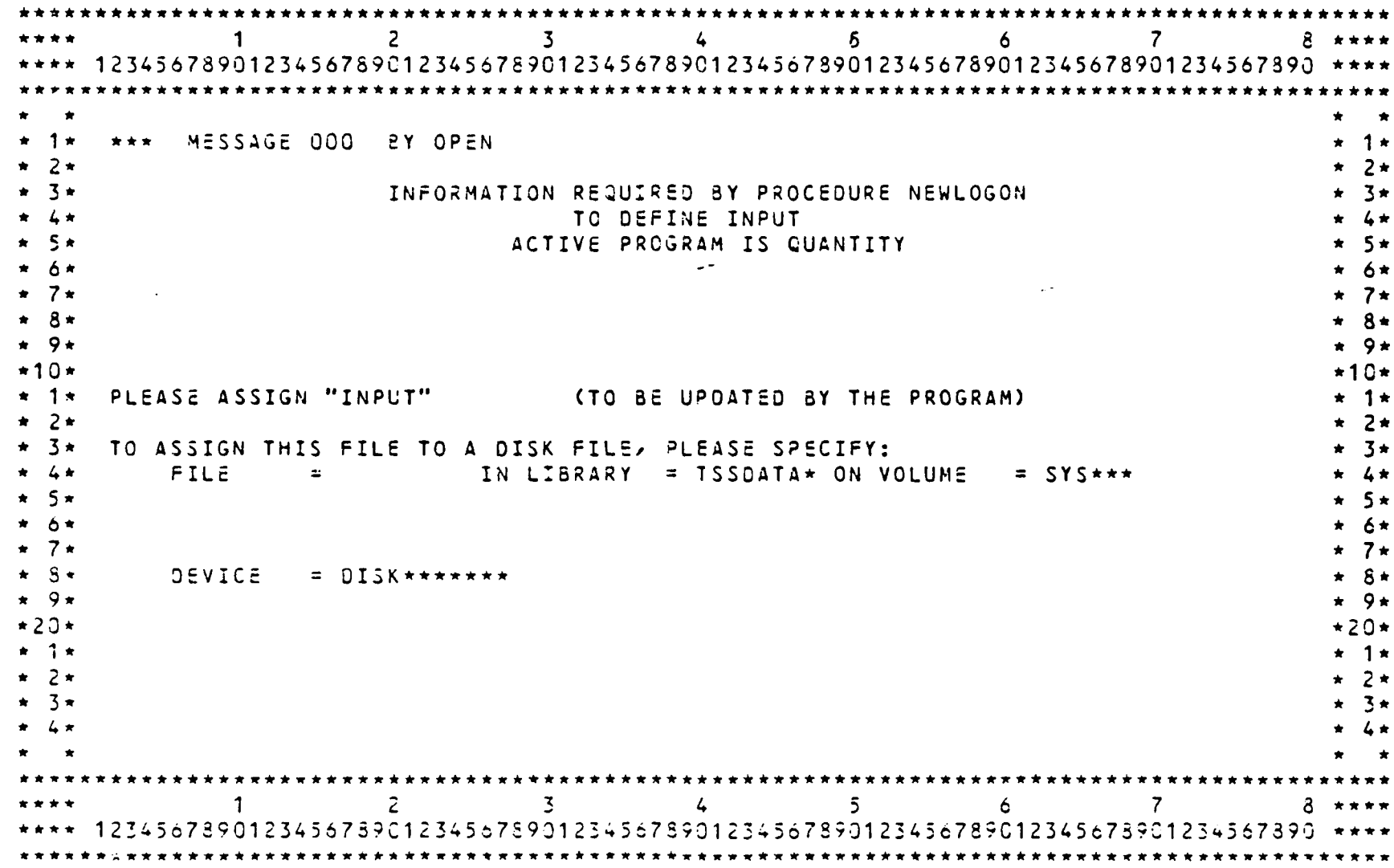
C151

Fig 124. Project Summary

```
**********************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
**********************************************************************************
*  *                                                                             *  *
* 1*  ***  MESSAGE 000  BY OPEN                                                  * 1*
* 2*                                                                             * 2*
* 3*                     INFORMATION REQUIRED BY PROCEDURE NEWLOGON               * 3*
* 4*                                TO DEFINE INPUT                              * 4*
* 5*                           ACTIVE PROGRAM IS QUANTITY                        * 5*
* 6*                                                                             * 6*
* 7*                                                                             * 7*
* 8*                                                                             * 8*
* 9*                                                                             * 9*
*10*                                                                             *10*
* 1*  PLEASE ASSIGN "INPUT"          (TO BE USED AS INPUT BY THE PROGRAM)        * 1*
* 2*                                                                             * 2*
* 3*  TO ASSIGN THIS FILE TO A DISK FILE, PLEASE SPECIFY:                        * 3*
* 4*      FILE     =          IN LIBRARY  = TSSDATA* ON VOLUME    = SYS***       * 4*
* 5*                                                                             * 5*
* 6*                                                                             * 6*
* 7*  TO SELECT ANOTHER DEVICE, SPECIFY:                                        * 7*
* 8*      DEVICE   = DISK*******   (ALTERNATES =DISK,NONE)                       * 8*
* 9*                                                                             * 9*
*20*                                                                             *20*
* 1*                                                                             * 1*
* 2*                                                                             * 2*
* 3*                                                                             * 3*
* 4*                                                                             * 4*
*  *                                                                             *  *
**********************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
**********************************************************************************
```

C152

Fig 125. Input File



C153

Fig 126. Input File Verified

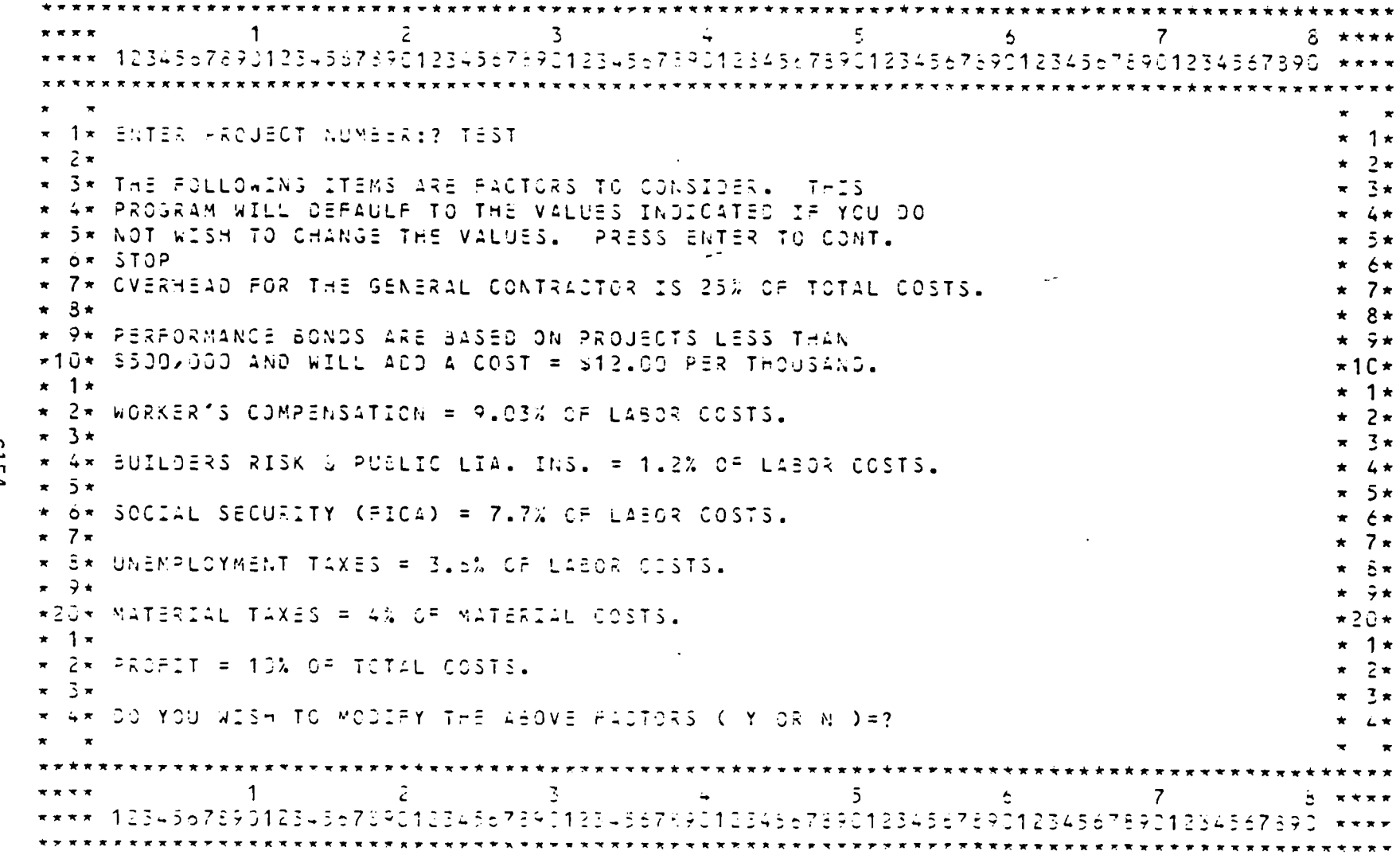


Fig 127. Default Values for Factors

```
**********************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
**********************************************************************************
*  *                                                                             *  *
* 1*                                                                             * 1*
* 2* UNEMPLOYMENT TAXES = 3.6% OF LABOR COSTS.                                   * 2*
* 3*                                                                             * 3*
* 4* MATERIAL TAXES = 4% OF MATERIAL COSTS.                                      * 4*
* 5*                                                                             * 5*
* 6* PROFIT = 10% OF TOTAL COSTS.                                                * 6*
* 7*                                                                             * 7*
* 8* DO YOU WISH TO MODIFY THE ABOVE FACTORS ( Y OR N )=? Y                      * 8*
* 9* PLEASE INPUT THE VALUES OR PERCENTAGES YOU WISH TO USE                      * 9*
*10* FOR THE FOLLOWING:                                                         *10*
* 1* OVERHEAD FOR THE GENERAL CONTRACTOR (% OF TOTAL COSTS) =? 0                 * 1*
* 2* PERFORMANCE BOND COSTS ($$ AMOUNT PER THOUSAND) =? .10                      * 2*
* 3* WORKER'S COMPENSATION (% OF LABOR COSTS) =? .5                              * 3*
* 4* BUILDERS RISK & PUBLIC LIA. INS. (% OF LABOR COSTS) =? .01                  * 4*
* 5* SOCIAL SECURITY TAXES (% OF LABOR COSTS) =? .077                            * 5*
* 6* UNEMPLOYMENT TAXES (% OF LABOR COSTS) =? .03                               * 6*
* 7* MATERIAL TAXES (% OF MATERIAL COSTS) =? .06                                * 7*
* 8* PROFIT (% OF TOTAL COSTS) =? .06                                           * 8*
* 9* DO YOU WISH TO ADD ANY OTHER FACTORS ( Y OR N ) =? Y                        * 9*
*20* ENTER NAME OF FACTOR (LIMIT TO 30 CHARACTERS) =? HAZARDOUS CONDITIONS      *20*
* 1* ENTER % OF TOTAL COST FOR THE FACTOR =? .20                                * 1*
* 2* DO YOU WISH TO ADD ANY OTHER FACTORS ( Y OR N ) =? N                        * 2*
* 3* END OF PROGRAM, PRESS ENTER TO EXIT                                        * 3*
* 4* STOP                                                                       * 4*
*  *                                                                             *  *
**********************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
**********************************************************************************
```

Fig 128. Modified Factors

```
**********************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
**********************************************************************************
*  *                                                                             *  *
* 1* WORKER'S COMPENSATION = 9.03% OF LABOR COSTS.                               * 1*
* 2*                                                                             * 2*
* 3* BUILDERS RISK & PUBLIC LIA. INS. = 1.2% OF LABOR COSTS.                      * 3*
* 4*                                                                             * 4*
* 5* SOCIAL SECURITY (FICA) = 7.7% OF LABOR COSTS.                                * 5*
* 6*                                                                             * 6*
* 7* UNEMPLOYMENT TAXES = 3.6% OF LABOR COSTS.                                    * 7*
* 8*                                                                             * 8*
* 9* MATERIAL TAXES = 4% OF MATERIAL COSTS.                                       * 9*
*10*                                                                             *10*
* 1* PROFIT = 10% OF TOTAL COSTS.                                                * 1*
* 2*                                                                             * 2*
* 3* DO YOU WISH TO MODIFY THE ABOVE FACTORS ( Y OR N )=? Y                       * 3*
* 4* PLEASE INPUT THE VALUES OR PERCENTAGES YOU WISH TO USE                       * 4*
* 5* FOR THE FOLLOWING:                                                          * 5*
* 6* OVERHEAD FOR THE GENERAL CONTRACTOR (% OF TOTAL COSTS) =? 0                  * 6*
* 7* PERFORMANCE BOND COSTS ($1 AMOUNT PER THOUSAND) =? .10                       * 7*
* 8* WORKER'S COMPENSATION (% OF LABOR COSTS) =? .5                              * 8*
* 9* BUILDERS RISK & PUBLIC LIA. INS. (% OF LABOR COSTS) =? .01                   * 9*
*20* SOCIAL SECURITY TAXES (% OF LABOR COSTS) =? .077                            *20*
* 1* UNEMPLOYMENT TAXES (% OF LABOR COSTS) =? .03                                * 1*
* 2* MATERIAL TAXES (% OF MATERIAL COSTS) =? .06                                 * 2*
* 3* PROFIT (% OF TOTAL COSTS) =? .06                                            * 3*
* 4* DO YOU WISH TO ADD ANY OTHER FACTORS ( Y OR N ) =?                           * 4*
*  *                                                                             *  *
**********************************************************************************
****          1         2         3         4         5         6         7         8 ****
**** 12345678901234567890123456789012345678901234567890123456789012345678901234567890 ****
**********************************************************************************
```

Fig 129. Additional Factors

APPENDIX A: ESTIMATE PROGRAM

```
000100 ************************************************************************
000200 *   THIS PROGRAM WILL FIND DATA FROM A DATA FILE BASED ON UCI          *
000300 *   CODE AND CALCULATE FINAL COSTS BASED ON QUANTITY INPUTS.           *
000400 *   A REPORT CAN BE GENERATED WHICH INCLUDES QUANTITIES AND            *
000500 *   FINAL COSTS USING THE QUANTITY PROGRAM.  THIS PROGRAM IS           *
000600 *   STEP ONE OF A SERIES TO GENERATE COSTS FOR A PROJECT.              *
000700 ************************************************************************
000800 *                                                                      *
000900 ************************************************************************
001000 *   HOW TO USE THIS PROGRAM:                                           *
001100 *   Step 1 - Complete the quantity take-off for the project            *
001200 *   and note the UCI CODE used to locate a particular                  *
001300 *   item from the data base.                                           *
001400 *   Step 2 - Run the ESTIMATE PROGRAM.  During this phrase a           *
001500 *   separate file is established based on the project                  *
001600 *   data in Step 1.  The program will prompt the user                  *
001700 *   for specific input items.  After all items have                    *
001800 *   been entered for the project exit the program.                     *
001900 *   Step 3 - Run the Wang Utility SORT on the quantity file            *
002000 *   created in Step 2.  One screen will ask for                        *
002100 *   "Please specify Sort/Merge keys:".  Complete                       *
002200 *   the screen as follows:                                             *
002300 *   Key 1:  POST1 = 0001  LENGTH1 = 003  TYPE = P                      *
002400 *   Key 2:  POST2 = 0004  LENGTH2 = 007  TYPE = P                      *
002500 *   The next screen will prompt for an output file.                    *
002600 *   Specify the same quantity file created in Step 2                   *
002700 *   and for the REPLACEoption type in YES.  The                        *
002800 *   file is now in ascending order based on UCI CODE.                  *
002900 *   Step 4 - Run the QUANTITY PROGRAM to generate a report on          *
003000 *   quantities and costs for the project using the                     *
003100 *   quantity file created in Step 3 as input.                          *
003200 *   Step 5 - Repeat Steps 3 and 4 for the Description file.            *
003300 *   Step 6 - Run the DESCRIPT PROGRAM to generate a detailed           *
003400 *   description of items used on the project.  This                    *
003500 *   report will not give total costs for the project.                  *
003600 ************************************************************************
003700 *
003800 DIM DES$ 40
003900 E = 0
004000 UCI = 0
004100 CODE = 0
004200 OUT = 0
004300 EQ = 0
004400 MATL = 0
004500 LAB = 0
004600 BCOS = 0
004700 TOT = 0
004800 *
004900 SELECT #1, "ESTIMATE", INDEXED, RECSIZE=150, KEYPOS=4, KEYLEN=7, !
```

```
005000 EOD GO TO 11400
005100 SELECT #2, "DESCRIPT", VAR,CONSEC, RECSIZE=150
005200 SELECT #3, "QUANTITY", VAR,CONSEC, RECSIZE=150
005300 *
005400 OPEN #1, INPUT
005500 *
005600 INPUT "UCI MAJOR DIVISION CODE (###) = ", UC
005700 INPUT "CODE SUB-DIVISION AND LINE NUMBER (########) = ", COD
005800 *
005900 READ #1, USING 6100, UCI, CODE, DES$, CREW$, OUT, UNIT$,EQ, MATL,!
006000 LAB, BCOS, TOT
006100 FMT COL(1), PD(5), COL(4),PD(13),COL(11),CH(40), CH(5), COL(56), !
006200 PD(9),CH(5),COL(66),PD(10,2), COL(72),PD(10,2), COL(78),PD(10,2),!
006300 COL(84), PD(10,2), COL(90), PD(10,2)
006400 IF UC = UCI AND COD = CODE THEN 6700 ELSE 6500
006500 GO TO 5900
006600 *
006700 PRINT "UCI",UCI, "CODE",CODE
006800 PRINT " "
006900 PRINT USING 7000, "DESCRIPTION",DES$
007000 FMT CH(40)
007100 PRINT " "
007200 PRINT "CREWSIZE",  "OUTPUT",  "UNITS"
007300 PRINT  CREW$,        OUT,      UNIT$
007400 PRINT " "
007500 PRINT "EQUIPMENT", "MATERIAL", "LABOR"
007600 PRINT   EQ,          MATL,       LAB
007700 PRINT " "
007800 PRINT "BARECOST", "TOTAL O&P"
007900 PRINT  BCOS,        TOT
008000 PRINT " "
008100 CLOSE #1
008200 *
008300 INPUT "IS ABOVE ITEM CORRECT ( Y OR N )=", H$
008400 IF H$ = "Y" THEN GO TO 8700
008500 IF H$ = "N" THEN GO TO 5400
008600 *
008700 INPUT "DO YOU WISH TO WRITE DATA TO ANOTHER FILE ( Y OR N ) OR   !
008800 CONTINUE TO ADD TO AN EXISTING FILE ( AD )=", C$
008900 IF C$ = "Y" THEN GOSUB 12800
009000 IF C$ = "N" THEN GO TO 11000
009100 IF C$ = "AD" THEN GOSUB 13100
009200 *
009300 INPUT "DO YOU WISH TO INSERT QUANTITIES  ( Y OR N ) ( QUANTITIES !
009400 MUST BE ADDED AT THIS TIME FOR CALCULATIONS TO BE UPDATED )", D$
009500 IF D$ = "Y" THEN GO TO 9800
009600 IF D$ = "N" THEN GO TO 11000
009700 *
009800 INPUT "WHAT IS YOUR QUANTITY FOR THIS ITEM=", E
009900 TBCOS = E * BCOS
010000 TTOT = E * TOT
010100 TBCOS = ROUND(TBCOS,2)
010200 TTOT = ROUND(TTOT,2)
```

```
010300 *
010400 INPUT "DO YOU WISH TO WRITE QUANTITIES TO ANOTHER FILE ( Y OR N )!
010500 OR CONTINUE TO ADD TO AN EXISTING FILE ( AD )=", F$
010600 IF F$ = "Y" THEN GOSUB 14700
010700 IF F$ = "N" THEN GO TO 11000
010800 IF F$ = "AD" THEN GOSUB 15000
010900 *
011000 INPUT "DO YOU WANT TO CONTINUE ( Y OR N )=", A$
011100 IF A$ = "Y" THEN GO TO 5400
011200 IF A$ = "N" THEN GO TO 12000
011300 *
011400 CLOSE #1
011500 PRINT "ITEM NOT FOUND IN DATA"
011600 INPUT "DO YOU WANT TO CHOOSE ANOTHER ITEM ( Y OR N )=", J$
011700 IF J$ = "Y" THEN GO TO 5400
011800 IF J$ = "N" THEN GO TO 12000
011900 *
012000 PRINT "END OF PROGRAM, PRESS ENTER TO EXIT"
012100 STOP
012200 *
012300 END
012400 *
012500 ********** SUB-ROUTINE TO WRITE AND ADD TO A FILE ****************
012600 *   THIS SUB-ROUTINE CREATES THE DESCRIPTION FILE                  *
012700 ************************************************************************
012800 OPEN #2, OUTPUT
012900 CLOSE #2
013000 *
013100 OPEN #1, INPUT
013200 OPEN #2, IO
013300 WRITE #2, USING                                                   !
013400 13600,UCI, CODE, DES$, CREW$, OUT, UNIT$,EQ, MATL,                !
013500 LAB, BCOS, TOT
013600 FMT COL(1), PD(5), COL(4),PD(13),COL(11),CH(40), CH(5), COL(56), !
013700 PD(9),CH(5),COL(66),PD(10,2), COL(72),PD(10,2), COL(78),PD(10,2),!
013800 COL(84), PD(10,2), COL(90), PD(10,2)
013900 *
014000 CLOSE #2
014100 CLOSE #1
014200 RETURN
014300 *
014400 ********** SUB-ROUTINE TO WRITE QUANTITIES TO A FILE ***************
014500 *      THIS SUB-ROUTINE CREATES THE QUANTITY FILE                  *
014600 ************************************************************************
014700 OPEN #3, OUTPUT
014800 CLOSE #3
014900 *
015000 OPEN #3, IO
015100 WRITE #3, USING 15300, UCI, CODE, DES$, CREW$, OUT, E, UNIT$,     !
015200 BCOS, TOT, TBCOS, TTOT
015300 FMT COL(1),PD(5), COL(4),PD(13), COL(11),CH(40), CH(5), COL(56), !
015400 PD(9), COL(61),PD(9), COL(66),CH(5), COL(71),PD(10,2), COL(77),  !
015500 PD(10,2), COL(83),PD(14,2), COL(91),PD(14,2)
```

```
015600 *
015700 CLOSE #3
015800 RETURN
015900 *
016000 ********************** END OF PROGRAM *******************************
```

APPENDIX B: CONVERT DESCRIPTION FILE TO INDEX FILE PROGRAM

```
000100 ************************************************************************
000200 *    THIS PROGRAM TAKES THE DESCRIPTION FILE CREATED IN THE            *
000300 *    ESTIMATE PROGRAM AND MAKES IT A VARIABLE-LENGTH INDEXED           *
000400 *    FILE WITH A KEY FIELD = DESCRIPT.  ONCE THE INDEXED               *
000500 *    FILE IS CREATED DELETIONS, ADDITIONS AND MODIFICATIONS            *
000600 *    CAN BE MADE WITHOUT RUNNING THE ESTIMATE PROGRAM.                 *
000700 ************************************************************************
000800 *
000900 DIM DES$ 40
001000 UCI=0
001100 CODE=0
001200 EQ=0
001300 MATL=0
001400 LAB=0
001500 BCOS=0
001600 TOT=0
001700 *
001800 SELECT #1, "INPUT", VAR,CONSEC, RECSIZE=150, EOD GO TO NO_DATA
001900 SELECT #2, "INDEX", VAR,INDEXED, RECSIZE=150, KEYPOS=11, KEYLEN=40
002000 *
002100 OPEN #1, INPUT
002200 OPEN #2, OUTPUT
002300 CLOSE #2
002400 OPEN #2, IO
002500 *
002600 GET_LIST:
002700 READ #1, USING 2900, UCI, CODE, DES$, CREW$, OUT, UNIT$, EQ,MATL,!
002800 LAB,BCOS,TOT
002900 FMT COL(1),PD(5),COL(4),PD(13),COL(11),CH(40),CH(5), COL(56),    !
003000 PD(9),CH(5),COL(66),PD(10,2), COL(72),PD(10,2), COL(78),PD(10,2),!
003100 COL(84),PD(10,2), COL(90),PD(10,2)
003200 *
003300 ************************************************************************
003400 *
003500 * THE FOLLOWING ITEMS ARE FOR CHECKING THE PROGRAM AND ARE NOT
003600 * NEEDED ONCE THE PROGRAM IS DEBUGGED.  PUT AN (*) AT THE
003700 * BEGINNING OF EACH LINE FOR THE PROGRAM TO SKIP OVER THE CODE.
003800 *
003900 *PRINT "UCI",UCI, "CODE",CODE
004000 *PRINT
004100 *PRINT USING 2500, "DESCRIPTION",DES$
004200 *FMT CH(40)
004300 *PRINT
004400 *PRINT "CREWSIZE",  "OUTPUT",  "UNITS"
004500 *PRINT  CREW$,       OUT,       UNIT$
004600 *PRINT
004700 *PRINT "EQUIPMENT", "MATERIAL", "LABOR"
004800 *PRINT   EQ,          MATL,       LAB
004900 *PRINT
```

```
005000 *PRINT "BARECOSTS", "TOTAL O&P"
005100 *PRINT  BCOS,          TOT
005200 *PRINT
005300 *STOP "PRESS ENTER TO CONTINUE"
005400 *
005500 ************************************************************************
005600 *
005700 WRITE #2, USING 5900, UCI, CODE, DES$, CREW$,OUT, UNIT$,EQ, MATL,!
005800 LAB, BCOS, TOT
005900 FMT COL(1),PD(5),COL(4),PD(13),COL(11),CH(40),CH(5), COL(56),    !
006000 PD(9),CH(5),COL(66),PD(10,2), COL(72),PD(10,2), COL(78),PD(10,2),!
006100 COL(84),PD(10,2), COL(90),PD(10,2)
006200 GO TO GET_LIST
006300 *
006400 NO_DATA:
006500 CLOSE #1
006600 CLOSE #2
006700 *
006800 PRINT "END OF PROGRAM, PRESS ENTER TO EXIT"
006900 STOP
007000 *
007100 END
007200 ************************** END OF PROGRAM **************************
```

APPENDIX C: CONVERT QUANTITY FILE TO INDEXED FILE PROGRAM

```
000100 ************************************************************************
000200 *    THIS PROGRAM TAKES THE QUANTITY FILE CREATED IN THE               *
000300 *    ESTIMATE PROGRAM AND MAKES IT A VARIABLE-LENGTH INDEXED           *
000400 *    FILE WITH A KEY FIELD = DESCRIPT.  ONCE THE INDEXED               *
000500 *    FILE IS CREATED DELETIONS, ADDITIONS AND MODIFICATIONS            *
000600 *    CAN BE MADE WITHOUT RUNNING THE ESTIMATE PROGRAM.                 *
000700 ************************************************************************
000800 *
000900 DIM DES$ 40
001000 E=0
001100 UCI=0
001200 CODE=0
001300 BCOS=0
001400 TOT=0
001500 TBCOS=0
001600 TTOT=0
001700 *
001800 SELECT #1, "INPUT", VAR,CONSEC, RECSIZE=150, EOD GO TO NO_DATA
001900 SELECT #2, "INDEX", VAR,INDEXED, RECSIZE=150, KEYPOS=11, KEYLEN=40
002000 *
002100 OPEN #1, INPUT
002200 OPEN #2, OUTPUT
002300 CLOSE #2
002400 OPEN #2, IO
002500 *
002600 GET_LIST:
002700 READ #1, USING 2900, UCI, CODE, DES$, CREW$, OUT, E, UNIT$,      !
002800 BCOS, TOT, TBCOS, TTOT
002900 FMT COL(1),PD(5),COL(4),PD(13),COL(11),CH(40),CH(5), COL(56),    !
003000 PD(9), COL(61),PD(9), COL(66),CH(5),COL(71),PD(10,2), COL(77),   !
003100 PD(10,2), COL(83),PD(14,2), COL(91),PD(14,2)
003200 *
003300 ************************************************************************
003400 *
003500 * THE FOLLOWING ITEMS ARE FOR CHECKING THE PROGRAM AND ARE NOT
003600 * NEEDED ONCE THE PROGRAM IS DEBUGGED.  PUT AN (*) AT THE
003700 * BEGINNING OF EACH LINE FOR THE PROGRAM TO SKIP OVER THE CODE.
003800 *
003900 *PRINT "UCI",UCI, "CODE",CODE
004000 *PRINT
004100 *PRINT USING 4100, "DESCRIPTION",DES$
004200 *FMT CH(40)
004300 *PRINT
004400 *PRINT "CREWSIZE",  "OUTPUT",  "QUANTITY",   "UNITS"
004500 *PRINT  CREW$,       OUT,         E,          UNIT$
004600 *PRINT
004700 *PRINT "BARECOST",  "TOTAL",    "TOTAL BARECOST",   "TOTAL O&P"
004800 *PRINT   BCOS,        TOT,          TBCOS,              TTOT
004900 *PRINT
```

```
005000 *STOP "PRESS ENTER TO CONTINUE"
005100 *
005200 ************************************************************************
005300 *
005400 WRITE #2, USING 5600, UCI, CODE, DES$, CREW$, OUT, E, UNIT$,     !
005500 BCOS, TOT, TBCOS, TTOT
005600 FMT COL(1),PD(5),COL(4),PD(13),COL(11),CH(40),CH(5), COL(56),    !
005700 PD(9), COL(61),PD(9), COL(66),CH(5), COL(71),PD(10,2), COL(77), !
005800 PD(10,2), COL(83),PD(14,2), COL(91),PD(14,2)
005900 GO TO GET_LIST
006000 *
006100 NO_DATA:
006200 CLOSE #1
006300 CLOSE #2
006400 *
006500 PRINT "END OF PROGRAM, PRESS ENTER TO EXIT"
006600 STOP
006700 *
006800 END
006900 ************************* END OF PROGRAM ***************************
```

APPENDIX D: DESCRIPTION REPORT PROGRAM

```
000100 ************************************************************************
000200 *      THIS PROGRAM IS TO BE USED IN CONJUNCTION WITH THE              *
000300 *      ESTIMATE PROGRAM TO GENERATE A DESCRIPTION REPORT IN            *
000400 *      ASCENDING ORDER BASED ON UCI CODE.                              *
000500 ************************************************************************
000600 *
000700 DIM DES$40
000800 DIM K$30
000900 DIM L$15
001000 UCI=0
001100 CODE=0
001200 EQ=0
001300 MATL=0
001400 LAB=0
001500 BCOS=0
001600 TOT=0
001700 *
001800 SELECT #1, "INPUT", CONSEC, RECSIZE=150, EOD GO TO NO_DATA
002000 *
002100 OPEN #1, INPUT
002200 CLOSE #1
002300 *
002400 PRINT "NEXT ENTER PROJECT NAME, LIMIT 30 CHARACTERS"
002500 INPUT "ENTER PROJECT NAME:", K$
002600 PRINT "NEXT ENTER PROJECT NUMBER, LIMIT 15 CHARACTERS"
002700 INPUT "ENTER PROJECT NUMBER:", L$
002800 *
002900 SELECT PRINTER
003000 *
003100 PRINT PAGE
003200 PRINT "PROJECT NAME:     ", K$
003300 PRINT "PROJECT NUMBER:   ", L$
003400 PRINT
003500 PRINT "*************************************************************!
003600 *************************************************************!
003700 ******"
003800 PRINT "*                                                          !
003900                                                                    !
004000      *"
004100 PRINT "*              DESCRIPTION REPORT                          !
004200                                                                    !
004300      *"
004400 PRINT "*                                                          !
004500                                                                    !
004600      *"
004700 PRINT "*************************************************************!
004800 *************************************************************!
004900 ******"
005000 PRINT
```

```
005100 PRINT USING 5300, "UCI CODE", "DESCRIPTION", "CREW", "OUTPUT",   !
005200 "UNITS", "EQUIP", "MATL", "LABOR", "BARECOST", "TOTAL O&P"
005300 FMT COL(2),CH(8), COL(26),CH(11), COL(56),CH(4), COL(63),CH(6),  !
005400 COL(71),CH(5), COL(78),CH(5), COL(88),CH(4), COL(97),CH(5),      !
005500 COL(104),CH(8), COL(114),CH(9)
005600 PRINT
005700 *
005800 OPEN #1, IO
005900 GET_LIST:
006000 READ #1, USING 6200, UCI,CODE,DES$,CREW$,OUT,UNIT$,EQ,MATL,LAB,  !
006100 BCOS,TOT
006200 FMT COL(1),PD(5),COL(4),PD(13),COL(11),CH(40), CH(5), COL(56),   !
006300 PD(9), CH(5),COL(66),PD(10,2),COL(72),PD(10,2),COL(78),PD(10,2), !
006400 COL(84),PD(10,2), COL(90),PD(10,2)
006500 IF UCI = 20 THEN GO TO 8100
006600 IF UCI = 30 THEN GO TO 8100
006700 IF UCI = 40 THEN GO TO 8100
006800 IF UCI = 50 THEN GO TO 8100
006900 IF UCI = 60 THEN GO TO 8100
007000 IF UCI = 70 THEN GO TO 8100
007100 IF UCI = 80 THEN GO TO 8100
007200 IF UCI = 90 THEN GO TO 8100
007300 IF UCI = 100 THEN GO TO 8100
007400 IF UCI = 110 THEN GO TO 8100
007500 IF UCI = 120 THEN GO TO 8100
007600 IF UCI = 130 THEN GO TO 8100
007700 IF UCI = 140 THEN GO TO 8100
007800 IF UCI = 150 THEN GO TO 8100
007900 IF UCI = 160 THEN GO TO 8100
008000 GO TO 8300
008100 PRINT
008200 *
008300 PRINT USING 8500, UCI,CODE,DES$,CREW$,OUT,UNIT$,EQ,MATL,LAB,     !
008400 BCOS,TOT
008500 FMT PIC(###),PIC(########),COL(13),CH(40),COL(56),CH(5),COL(64),  !
008600 PIC(######),COL(72),CH(5),COL(78),PIC(#####.##),COL(87),          !
008700 PIC(#####.##),COL(96),PIC(#####.##),COL(105),PIC(#####.##),COL(114),!
008800 PIC(#####.##)
008900 GO TO GET_LIST
009000 *
009100 NO_DATA:
009200 CLOSE #1
009300 *
009400 SELECT WS
009500 PRINT "END OF PROGRAM, PRESS ENTER TO EXIT"
009600 STOP
009700 *
009800 END
009900 ************************ END OF PROGRAM ****************************
```

APPENDIX E: QUANTITY REPORT PROGRAM

```
000100 ************************************************************************
000200 *       THIS PROGRAM IS TO BE USED IN CONJUNCTION WITH THE             *
000300 *       ESTIMATE PROGRAM TO GENERATE A QUANTITY REPORT IN              *
000400 *       ASCENDING ORDER BASED ON UCI CODE.                             *
000500 ************************************************************************
000600 *
000700 DIM DES$40
000800 DIM K$30
000900 DIM L$15
001000 DIM D$1
001100 DIM F$1
001200 DIM ADDA$30
001300 DIM ADDB$30
001400 DIM ADDE$30
001500 DIM ADDD$30
001600 *
001700 UCI=0
001800 CODE=0
001900 OUT=0
002000 E=0
002100 BCOS=0
002200 TOT=0
002300 TBCOSI=0
002400 TTOTI=0
002500 TB1=0
002600 TB2=0
002700 TB3=0
002800 TB4=0
002900 TB5=0
003000 TB6=0
003100 TB7=0
003200 TB8=0
003300 TB9=0
003400 TB10=0
003500 TB11=0
003600 TB12=0
003700 TB13=0
003800 TB14=0
003900 TB15=0
004000 TB16=0
004100 *
004200 SELECT #1, "INPUT", CONSEC, RECSIZE=150, EOD GO TO NO_DATA
004300 *
004400 OPEN #1, INPUT
004500 CLOSE #1
004600 *
004700 PRINT "NEXT ENTER PROJECT NAME, LIMIT TO 30 CHARACTERS"
004800 INPUT "ENTER PROJECT NAME:", K$
004900 PRINT "NEXT ENTER PROJECT NUMBER, LIMIT TO 15 CHARACTERS"
005000 INPUT "ENTER PROJECT NUMBER:", L$
005100 *
```

```
005200 SELECT PRINTER
005300 *
005400 PRINT PAGE
005500 PRINT "PROJECT NAME:      ", K$
005600 PRINT "PROJECT NUMBER:    ", L$
005700 PRINT
005800 PRINT "*****************************************************************!
005900 *****************************************************************!
006000 ******"
006100 PRINT "*                                                               !
006200                                                                        !
006300      *"
006400 PRINT "*              QUANTITY TAKE-OFF REPORT                         !
006500                                                                        !
006600      *"
006700 PRINT "*                                                               !
006800                                                                        !
006900      *"
007000 PRINT "*****************************************************************!
007100 *****************************************************************!
007200 ******"
007300 PRINT
007400 PRINT USING 7700, "UCI-CODE", "DESCRIPTION", "CREW", "DAILY",     !
007500 "QUANTITY", "UNITS", "BARE UNIT", "TOTAL UNIT", "TOTAL BARE",     !
007600 "TOTAL COSTS"
007700 FMT COL(2),CH(8), COL(15),CH(11), COL(54),CH(4), COL(60),CH(5),   !
007800 COL(67),CH(8), COL(76),CH(5), COL(82),CH(9), COL(92),CH(10),      !
007900 COL(104),CH(10), COL(117),CH(11)
008000 *
008100 PRINT USING 8300, "SIZE", "OUTPUT","COSTS","INC. O & P", "COSTS",!
008200 "INC. O & P"
008300 FMT COL(54),CH(4), COL(60),CH(6), COL(84),CH(5), COL(92),CH(10), !
008400 COL(107),CH(5), COL(117),CH(10)
008500 PRINT
008600 *
008700 OPEN #1, IO
008800 GET_LIST:
008900 READ #1, USING 9100, UCI, CODE, DES$, CREW$, OUT, E, UNIT$, BCOS,!
009000 TOT,TBCOS,TTOT
009100 FMT COL(1),PD(5),COL(4),PD(13),COL(11),CH(40),CH(5), COL(56),     !
009200 PD(9),COL(61),PD(9),COL(66),CH(5), COL(71),PD(10,2), COL(77),     !
009300 PD(10,2), COL(83),PD(14,2),COL(91),PD(14,2)
009400 TBCOSI=TBCOS+TBCOSI
009500 TTOTI=TTOT+TTOTI
009600 IF UCI   10 AND UCI   20 THEN GO TO 11300
009700 IF UCI   20 AND UCI   30 THEN GO TO 11300
009800 IF UCI   30 AND UCI   40 THEN GO TO 11300
009900 IF UCI   40 AND UCI   50 THEN GO TO 11300
010000 IF UCI   50 AND UCI   60 THEN GO TO 11300
010100 IF UCI   60 AND UCI   70 THEN GO TO 11300
010200 IF UCI   70 AND UCI   80 THEN GO TO 11300
010300 IF UCI   80 AND UCI   90 THEN GO TO 11300
010400 IF UCI   90 AND UCI   100 THEN GO TO 11300
010500 IF UCI   100 AND UCI   110 THEN GO TO 11300
010600 IF UCI   110 AND UCI   120 THEN GO TO 11300
```

```
010700 IF UCI   120 AND UCI   130 THEN GO TO 11300
010800 IF UCI   130 AND UCI   140 THEN GO TO 11300
010900 IF UCI   140 AND UCI   150 THEN GO TO 11300
011000 IF UCI   150 AND UCI   160 THEN GO TO 11300
011100 IF UCI   160 THEN GO TO 11300
011200 GO TO 9100
011300 TBI = TBCOS + TBI
011400 TOTI = TTOT + TOTI
011500 IF UCI = 20 THEN GO TO 13100
011600 IF UCI = 30 THEN GO TO 13100
011700 IF UCI = 40 THEN GO TO 13100
011800 IF UCI = 50 THEN GO TO 13100
011900 IF UCI = 60 THEN GO TO 13100
012000 IF UCI = 70 THEN GO TO 13100
012100 IF UCI = 80 THEN GO TO 13100
012200 IF UCI = 90 THEN GO TO 13100
012300 IF UCI = 100 THEN GO TO 13100
012400 IF UCI = 110 THEN GO TO 13100
012500 IF UCI = 120 THEN GO TO 13100
012600 IF UCI = 130 THEN GO TO 13100
012700 IF UCI = 140 THEN GO TO 13100
012800 IF UCI = 150 THEN GO TO 13100
012900 IF UCI = 160 THEN GO TO 13100
013000 GO TO 13900
013100 PRINT USING 13200, "----------------------------"
013200 FMT COL(102),CH(28)
013300 PRINT USING 13400, "TOTAL DIVISION COSTS", TBI,TOTI
013400 FMT COL(1),CH(20), COL(103),PIC(##########.##), COL(116),          !
013500 PIC(##########.##)
013600 TBI = 0
013700 TOTI = 0
013800 *
013900 IF UCI   10 AND UCI   20 THEN GO TO 15600
014000 IF UCI   20 AND UCI   30 THEN GO TO 15800
014100 IF UCI   30 AND UCI   40 THEN GO TO 16000
014200 IF UCI   40 AND UCI   50 THEN GO TO 16200
014300 IF UCI   50 AND UCI   60 THEN GO TO 16400
014400 IF UCI   60 AND UCI   70 THEN GO TO 16600
014500 IF UCI   70 AND UCI   80 THEN GO TO 16800
014600 IF UCI   80 AND UCI   90 THEN GO TO 17000
014700 IF UCI   90 AND UCI   100 THEN GO TO 17200
014800 IF UCI   100 AND UCI   110 THEN GO TO 17400
014900 IF UCI   110 AND UCI   120 THEN GO TO 17600
015000 IF UCI   120 AND UCI   130 THEN GO TO 17800
015100 IF UCI   130 AND UCI   140 THEN GO TO 18000
015200 IF UCI   140 AND UCI   150 THEN GO TO 18200
015300 IF UCI   150 AND UCI   160 THEN GO TO 18400
015400 IF UCI   160 THEN GO TO 18600
015500 GO TO 18700
015600 TB1 = TBCOS + TB1
015700 GO TO 18700
015800 TB2 = TBCOS + TB2
015900 GO TO 18700
016000 TB3 = TBCOS + TB3
016100 GO TO 18700
```

```
016200 TB4 = TBCOS + TB4
016300 GO TO 18700
016400 TB5 = TBCOS + TB5
016500 GO TO 18700
016600 TB6 = TBCOS + TB6
016700 GO TO 18700
016800 TB7 = TBCOS + TB7
016900 GO TO 18700
017000 TB8 = TBCOS + TB8
017100 GO TO 18700
017200 TB9 = TBCOS + TB9
017300 GO TO 18700
017400 TB10 = TBCOS + TB10
017500 GO TO 18700
017600 TB11 = TBCOS + TB11
017700 GO TO 18700
017800 TB12 = TBCOS + TB12
017900 GO TO 18700
018000 TB13 = TBCOS + TB13
018100 GO TO 18700
018200 TB14 = TBCOS + TB14
018300 GO TO 18700
018400 TB15 = TBCOS + TB15
018500 GO TO 18700
018600 TB16 = TBCOS + TB16
018700 *
018800 PRINT
018900 PRINT USING 19100, UCI, CODE, DES$, CREW$, OUT, E, UNIT$,        !
019000 BCOS, TOT, TBCOS, TTOT
019100 FMT PIC(###),PIC(########),COL(12),CH(40),COL(54),CH(5),COL(60),  !
019200 PIC(######),COL(67),PIC(#########),COL(76),CH(5), COL(82),        !
019300 PIC(#######.##), COL(92),PIC(#######.##), COL(104),               !
019400 PIC(#########.##), COL(117),PIC(#########.##)
019500 GO TO GET_LIST
019600 *
019700 NO_DATA:
019800 PRINT USING 19900, "----------------------------"
019900 FMT COL(102),CH(28)
020000 PRINT USING 20100, "TOTAL DIVISION COSTS", TBI,TOTI
020100 FMT COL(1),CH(20), COL(103),PIC(##########.##), COL(116),         !
020200 PIC(##########.##)
020300 PRINT
020400 PRINT
020500 PRINT USING 20600, "----------------------------"
020600 FMT COL(102),CH(28)
020700 PRINT USING 20800, "TOTAL PROJECT COSTS", TBCOSI, TTOTI
020800 FMT COL(1),CH(19), COL(103),PIC(##########.##), COL(116),         !
020900 PIC(##########.##)
021000 CLOSE #1
021100 *
021200 SELECT WS
021300 PRINT
021400 PRINT "THE FOLLOWING ITEMS ARE FACTORS TO CONSIDER.  THIS"
021500 PRINT "PROGRAM WILL DEFAULT TO THE VALUES INDICATED BELOW"
021600 PRINT "IF YOU DO NOT WISH TO CHANGE THE VALUES.  PRESS ENTER"
```

```
021700 STOP
021800 PRINT "OVERHEAD FOR THE GENERAL CONTRACTOR IS 25% OF TOTAL COSTS."
021900 PRINT
022000 PRINT "PERFORMANCE BONDS ARE BASED ON PROJECTS LESS THAN"
022100 PRINT "$500,000 AND WILL ADD A COST = $12.00 PER THOUSAND."
022200 PRINT
022300 PRINT "WORKER'S COMPENSATION = 9.03% OF LABOR COSTS."
022400 PRINT
022500 PRINT "BUILDERS RISK & PUBLIC LIA. INS. = 1.2% OF LABOR COSTS."
022600 PRINT
022700 PRINT "SOCIAL SECURITY (FICA) = 7.7% OF LABOR COSTS."
022800 PRINT
022900 PRINT "UNEMPLOYMENT TAXES = 3.6% OF LABOR COSTS."
023000 PRINT
023100 PRINT "MATERIAL TAXES = 4% OF MATERIAL COSTS."
023200 PRINT
023300 PRINT "PROFIT = 10% OF TOTAL COSTS."
023400 PRINT
023500 INPUT "DO YOU WISH TO MODIFY THE ABOVE FACTORS ( Y OR N )=",D$
023600 IF D$ = "N" THEN GO TO 23800
023700 IF D$ = "Y" THEN GO TO 24700
023800 OVER = .25
023900 PERF = 12.00
024000 WCOMP = .0903
024100 INS = .012
024200 FICA = .077
024300 UNEMP = .036
024400 MATI = .040
024500 PROF = .10
024600 GO TO 25900
024700 PRINT "PLEASE INPUT THE VALUES OR PERCENTAGES YOU WISH TO USE"
024800 PRINT "FOR THE FOLLOWING:"
024900 INPUT "OVERHEAD FOR THE GENERAL CONTRACTOR (% OF TOTAL COSTS) =".!
025000 OVER
025100 INPUT "PERFORMANCE BOND COSTS ($$ AMOUNT PER THOUSAND) =",PERF
025200 INPUT "WORKER'S COMPENSATION (% OF LABOR COSTS) =",WCOMP
025300 INPUT "BUILDERS RISK & PUBLIC LIA. INS. (% OF LABOR COSTS) =",    !
025400 INS
025500 INPUT "SOCIAL SECURITY TAXES (% OF LABOR COSTS) =",FICA
025600 INPUT "UNEMPLOYMENT TAXES (% OF LABOR COSTS) =",UNEMP
025700 INPUT "MATERIAL TAXES (% OF MATERIAL COSTS) =",MATI
025800 INPUT "PROFIT (% OF TOTAL COSTS) =",PROF
025900 LAB = .6 * TBCOSI
026000 MATE = .4 * TBCOSI
026100 TOVER = OVER * TBCOSI
026200 TPERF = PERF * (TBCOSI/1000)
026300 TWCOMP = WCOMP * LAB
026400 TINS = INS * LAB
026500 TFICA = FICA * LAB
026600 TUNEMP = UNEMP * LAB
026700 TMAT = MATI * MATE
026800 TPROF = PROF * TBCOSI
026900 PROJ = TOVER + TPERF + TWCOMP + TINS + TFICA + TUNEMP + TMAT +    !
027000 TPROF
027100 TPROF = PROJ + TBCOSI
```

```
027200 FACA = 0
027300 FACB = 0
027400 FACC = 0
027500 FACD = 0
027600 ADDA$ = "NOT USED"
027700 ADDB$ = "NOT USED"
027800 ADDE$ = "NOT USED"
027900 ADDD$ = "NOT USED"
028000 INPUT "DO YOU WISH TO ADD ANY OTHER FACTORS ( Y OR N ) =",F$
028100 IF F$ = "Y" THEN GO TO 28300
028200 IF F$ = "N" THEN GO TO 30400
028300 INPUT "ENTER NAME OF FACTOR (LIMIT TO 30 CHARACTERS) =",ADDA$
028400 INPUT "ENTER % OF TOTAL COST FOR THE FACTOR =",FACA
028500 TFACA = FACA * TBCOSI
028600 INPUT "DO YOU WISH TO ADD ANY OTHER FACTORS ( Y OR N ) =",F$
028700 IF F$ = "Y" THEN GO TO 28900
028800 IF F$ = "N" THEN GO TO 30400
028900 INPUT "ENTER NAME OF FACTOR (LIMIT TO 30 CHARACTERS) =",ADDB$
029000 INPUT "ENTER % OF TOTAL COST FOR THE FACTOR =",FACB
029100 TFACB = FACB * TBCOSI
029200 INPUT "DO YOU WISH TO ADD ANY OTHER FACTORS ( Y OR N ) =",F$
029300 IF F$ = "Y" THEN GO TO 29500
029400 IF F$ = "N" THEN GO TO 30400
029500 INPUT "ENTER NAME OF FACTOR (LIMIT TO 30 CHARACTERS) =",ADDE$
029600 INPUT "ENTER % OF TOTAL COST FOR THE FACTOR =",FACE
029700 TFACC = FACC * TBCOSI
029800 INPUT "DO YOU WISH TO ADD ANY OTHER FACTORS ( Y OR N ) =",F$
029900 IF F$ = "Y" THEN GO TO 30100
030000 IF F$ = "N" THEN GO TO 30400
030100 INPUT "ENTER NAME OF FACTOR (LIMIT TO 30 CHARACTERS) =",ADDD$
030200 INPUT "ENTER % OF TOTAL COST FOR THE FACTOR =",FACD
030300 TFACD = FACD * TBCOSI
030400 TTFAC = TFACA + TFACB + TFACC + TFACD
030500 TTPROJ = TTFAC + TPROJ
030600 *
030700 SELECT PRINTER
030800 *
030900 PRINT PAGE
031000 PRINT "PROJECT NAME:     ",K$
031100 PRINT "PROJECT NUMBER:   ",L$
031200 PRINT
031300 PRINT "*****************************************************************!
031400 *****************************************************************!
031500 ******"
031600 PRINT "*                                                               !
031700                                                                        !
031800      *"
031900 PRINT "*              PROJECT SUMMARY                                  !
032000                                                                        !
032100      *"
032200 PRINT "*                                                               !
032300                                                                        !
032400      *"
032500 PRINT "*****************************************************************!
032600 *****************************************************************!
```

```
032700 ******"
032800 PRINT
032900 PRINT USING 33000,"SPECIFICATION DIVISION","TOTAL BARE COSTS"
033000 FMT COL(6),CH(22), COL(48),CH(16)
033100 PRINT USING 34700,"DIVISION 1 GENERAL CONDITIONS",TB1
033200 PRINT USING 34700,"DIVISION 2 SITE WORK",TB2
033300 PRINT USING 34700,"DIVISION 3 CONCRETE",TB3
033400 PRINT USING 34700,"DIVISION 4 MASONRY",TB4
033500 PRINT USING 34700,"DIVISION 5 METALS",TB5
033600 PRINT USING 34700,"DIVISION 6 WOOD & PLASTICS",TB6
033700 PRINT USING 34700,"DIVISION 7 MOISTURE & THERMAL PROTECTION",TB7
033800 PRINT USING 34700,"DIVISION 8 DOORS, WINDOWS & GLASS",TB8
033900 PRINT USING 34700,"DIVISION 9 FINISHES",TB9
034000 PRINT USING 34700,"DIVISION 10 SPECIALTIES",TB10
034100 PRINT USING 34700,"DIVISION 11 EQUIPMENT",TB11
034200 PRINT USING 34700,"DIVISION 12 FURNISHINGS",TB12
034300 PRINT USING 34700,"DIVISION 13 SPECIAL CONSTRUCTION",TB13
034400 PRINT USING 34700,"DIVISION 14 CONVEYING SYSTEMS",TB14
034500 PRINT USING 34700,"DIVISION 15 MECHANICAL",TB15
034600 PRINT USING 34700,"DIVISION 16 ELECTRICAL",TB16
034700 FMT COL(1),CH(41), COL(50),PIC(##########.##)
034800 PRINT USING 34900, "---------------"
034900 FMT COL(48),CH(15)
035000 PRINT USING 35100, "TOTAL BARE COSTS",TBCOSI, TBCOSI
035100 FMT COL(1),CH(17), COL(50),PIC(##########.##) COL(80),          !
035200 PIC(##########.##)
035300 PRINT
035400 PRINT USING 035500, "OVERHEAD/PROFIT FACTORS"
035500 FMT COL(6),CH(25)
035600 PRINT USING 36400,"OVERHEAD FOR GENERAL CONTRACTOR",OVER, TOVER
035700 PRINT USING 36400,"PERFORMANCE BOND ($$/THOUSAND)",PERF, TPERF
035800 PRINT USING 36400,"WORKER'S COMPENSATION",WCOMP, TWCOMP
035900 PRINT USING 36400,"BUILDERS RISK & PUBLIC LIA. INS.",INS, TINS
036000 PRINT USING 36400,"SOCIAL SECURITY TAX",FICA, TFICA
036100 PRINT USING 36400,"UNEMPLOYMENT TAX",UNEMP, TUNEMP
036200 PRINT USING 36400,"MATERIAL TAX",MATI, TMAT
036300 PRINT USING 36400,"PROFIT",PROF, TPROF
036400 FMT COL(1),CH(33), COL(35),PIC(##.####), COL(50),PIC(##########.##)
036500 PRINT USING 36600, "---------------"
036600 FMT COL(48),CH(15)
036700 PRINT USING 36800, "TOTAL OVERHEAD/PROFIT",PROJ, PROJ
036800 FMT COL(1),CH(22), COL(50),PIC(##########.##), COL(80),          !
036900 PIC(##########.##)
037000 PRINT
037100 PRINT USING 37200, "OTHER FACTORS"
037200 FMT COL(6),CH(15)
037300 PRINT USING 37700, ADDA$, FACA, TFACA
037400 PRINT USING 37700, ADDB$, FACB, TFACB
037500 PRINT USING 37700, ADDE$, FACC, TFACC
037600 PRINT USING 37700, ADDD$, FACD, TFACD
037700 FMT COL(1),CH(30), COL(35),PIC(##.###), COL(50),PIC(##########.##)
037800 PRINT USING 37900, "---------------"
037900 FMT COL(48),CH(15)
038000 PRINT USING 38100, "TOTAL ADDITIONAL FACTORS",TTFAC, TTFAC
038100 FMT COL(1),CH(25), COL(50),PIC(##########.##), COL(80),          !
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APPENDIX D: PERSONAL INTERVIEWS

1. Anderson, Blaine, GS-11, Mechanical Engineer. Personal interview. Estimating, 12 February 1986.

2. Campbell, Joan A., GS-9, Electrical Engineer. Personal interview. Estimating, 26 February 1986.

3. Cowan, Lynwood W., 1lt, Civil Engineer. Personal interview. Estimating, 12 February 1986.

4. Eutrekin, Walter E., GS-11, Base Architect. Personal interview. Estimating, 26 February 1986.

5. Gaisford, David I., 1LT, Architectural Engineer. Personal interview. Estimating, 12 February 1986.

6. Flilya, Michael, 1LT, Civil Design Engineer. Personal interview. Estimating, 26 February 1986.

7. Jackson, Steve, 2LT, Architectural Engineer. Personal interview. Estimating, 12 February 1986.

8. Kontess, William G., 2LT, Base Architect. Personal interview. Estimating, 12 February 1986.

9. Lacatus, Joseph, 2LT, Electrical Design Engineer. Personal interview. Estimating, 12 February 1986.

10. Morgan, Kevin L., GS-7, Civil Engineer. Personal interview. Estimating, 26 February 1986.

11. Parham, Johnny, 1LT, Civil Engineer. Personal interview. Estimating, 26 February 1986.

12. Soderlund, Bruce R., GS-11, Electrical Engineer. Personal interview. Estimating, 12 February 1986.

13. Young Don, GS-7, Civil Engineer. Personal interview. Estimating, 26 February 1986.

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VITA

Captain Steven R. Stark was born on 30 September 1955 in Springfield, Missouri. He graduated from high school in Springfield, Missouri in 1973 and attended the University of Arkansas at Fayetteville where he received the degree of Bachelor of Arts in Architecture in May 1978. Upon graduation, he received a commission in the USAF through the ROTC program with a reporting date of July 1978. He served three years at K. I. Sawyer Air Force Base in Michigan working in the 410th Combat Support Group Civil Engineering Squadron as the Base Architect. He later attended the Education With Industry Program sponsored by the Architect/Engineering firm of Daniel, Mann, Johnson and Mendenhall. In 1982 he moved to Wright-Patterson Air Force Base and was an Assistant Professor of Architecture in the School of Civil Engineering. Captain Stark is now the Chief of Engineering (DEE) for the 5099th Civil Engineering Operations Squadron at Elmendorf AFB, Alaska.

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1a. REPORT SECURITY CLASSIFICATION: UNCLASSIFIED	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION/AVAILABILITY OF REPORT: Approved for public release; distribution unlimited.
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4. PERFORMING ORGANIZATION REPORT NUMBER(S): AFIT/GEM/LSA/86S-26	5. MONITORING ORGANIZATION REPORT NUMBER(S)
6a. NAME OF PERFORMING ORGANIZATION: School of Systems and Logistics; 6b. OFFICE SYMBOL (If applicable): AFIT/LSM	7a. NAME OF MONITORING ORGANIZATION
6c. ADDRESS (City, State and ZIP Code): Air Force Institute of Technology, Wright-Patterson AFB, OH 45433-6583	7b. ADDRESS (City, State and ZIP Code)
8a. NAME OF FUNDING/SPONSORING ORGANIZATION; 8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c. ADDRESS (City, State and ZIP Code)	10. SOURCE OF FUNDING NOS. — PROGRAM ELEMENT NO. / PROJECT NO. / TASK NO. / WORK UNIT NO.
11. TITLE (Include Security Classification): See Block 19	
12. PERSONAL AUTHOR(S): Steven R. Stark, B.A., Capt, USAF	
13a. TYPE OF REPORT: MS Thesis; 13b. TIME COVERED: FROM _____ TO _____; 14. DATE OF REPORT (Yr., Mo., Day): 1986 June; 15. PAGE COUNT: 260	
16. SUPPLEMENTARY NOTATION	

17 COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB. GR.	
14	01		Costs, Estimating, Construction, Civil Engineering Bid Costs

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

Title: FORMULATION OF A CONSTRUCTION COST ESTIMATING PROCEDURE TO AID DESIGNERS IN PREPARING DETAILED CONSTRUCTION COST ESTIMATES

Thesis Advisor: Dale Shields, Lt Col, USAF

Approved for public release: IAW AFR 190-1.
[signature] 24 Sept 86
Dean for Research and Professional Development
Air Force Institute of Technology (AFIT)
Wright-Patterson AFB OH 45433

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT: UNCLASSIFIED/UNLIMITED ☒ SAME AS RPT. ☐ OTIC USERS ☐	21. ABSTRACT SECURITY CLASSIFICATION: UNCLASSIFIED
22a. NAME OF RESPONSIBLE INDIVIDUAL: Dale Shields, Lt Col, USAF	22b. TELEPHONE NUMBER (Include Area Code): 513-255-6857; 22c. OFFICE SYMBOL: AFIT/LSA

DD FORM 1473, 83 APR — EDITION OF 1 JAN 73 IS OBSOLETE.

This thesis examined several existing cost estimating data bases. In addition to these data bases a survey was taken amoung Air Force Civil Engineering Design personnel to determine which estimating system is currently in use and what factors effect the final costs on construction projects. Based on the results of the surveys an estimating program was developed to enable the designer to input local cost data and store the data for future use. With the data base in place the designer is able to create accurate cost estimates in less time for each particular project and have the project data stored under the particular project name/code. The computer programs developed for this thesis were written in BASIC language and compatible with the WANG VS 100 system.

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